



1938
**MODEL AERONAUTICS
YEARBOOK**

BY FRANK ZAIC



D. H. Shipton

1938
MODEL AERONAUTICS
YEAR BOOK

Edited by
Frank Zaic



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TO

VISCOUNT WAKEFIELD OF HYTHE

G.C.V.O., C.B.E., Hon.F.R.Ae.S.

and

Donald S. Bird †

3169 Reach Street
Philadelphia, Pa.

February 4, 1938

Dear Frank,

Ever since the 1936 nationals at Detroit, I have been isolated from model airplane activities; nevertheless I will try to give you a picture of the progress in general from my past experience.

Nothing in our age, I have observed, is a better hobby than building and flying model airplanes. It is dignifying and inspiring to young and old, and above all - it is educational. The sending of teams to compete in foreign countries has helped to form brotherhood and goodwill, and perhaps everlasting friendship.

The National contests, as I understand, are getting to be bigger and better every year, and to all who attend, it is like a grand festival. It was not so long ago when I had competed in National contests, and as to whether we win or lose, we always learn the true tradition of what it takes to be a good sportman. When the last curtain falls on the banquet that concludes the National meet we could almost cry, even though we win nothing we had a good time. However, the loser in many cases, will be the "champ" for the following year.

Now about the N.A.A. set up, I think the whole thing is good because it is a governing body and the rules adopted, are always satisfying to the average model builder. I heard Lieut. H. W. Alden is out of the organizing end, and I do think that it is disappointing for many of us who knew him; furthermore it is going to be pretty hard to find someone to take his place, because of the great work which he has done in the past. But we do hope that he may come back again someday.

Well, Frank, I wish I had something worthwhile to contribute to your book, as I had in the past, or perhaps next year - !

Sincerely yours,

John Haw

THEORY

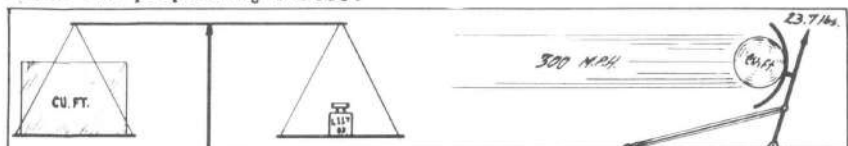
AERODYNAMICS

It is common knowledge that flight depends on the difference of pressure on the upper and lower portion of the wing; high pressures on bottom and reduced pressure on the top. We can tangle ourselves in fluid flow theory which would mathematically prove the phenomena, or we can take the scientists' word for it. But since most of us possess inquisitive minds, we might as well know what goes on. The following visual picture of the airflow action on wings is intended to make it possible for us to realize the difference between action at high and low speeds.

PROPERTIES OF AIR

It is only sensible to know something about air since it is the medium in which we work. To most of us it is still empty void. If such were the case, we would be flying rockets instead of airplanes. The flight depends on the physical law of "to every action there is an equal and opposite reaction." This means that the airplanes must have some substance to react upon to remain aloft and counteract gravity.

We are often reminded of the vast ocean of air in which we live. Also that if we were to cut a cubic foot of air on the bottom of this ocean and place it in a vacuum room, it would weigh 1.227 ozs. The air now has body. Let's imagine that this cubic foot of air is fired from a cannon at a speed of 300 m.p.h. This speed multiplied by the weight of cubic foot of air will provide kinetic energy of 386 ozs. or 237 lbs. Quite a blow from an invisible substance. The wind is this sort of energy. Nature, with its high and low pressure regions, provides the propelling forces.



The given flight theory of increased and decreased pressure deceives many of us into believing that we have compression on the lower portion of the wing. For practical accurate calculating purposes we can disregard it as long as we keep under 300 m.p.h. At speeds below 300 m.p.h. the wing is a very poor compressor because the air is a very lively medium, and it escapes in all directions to avoid being crushed. It is not like a bicycle pump where a pressure of 40 or 50 lbs. may be exerted on 2 sq. in. on top of confined air. A much better thought to keep in mind about the air is to liken it to water and as such it resents change of motion.

Besides having weight, the air also has the property of close cohesion among its molecules. This state of affairs is called viscosity. To have a better visualization of air we might liken its molecules to tiny octupi with arms all around its body, and that every arm is clutching an arm of the surrounding molecular octopus. We now have a sort of a three dimensional web. This illustration may be far fetched but it will explain many facts now known to us by name only.

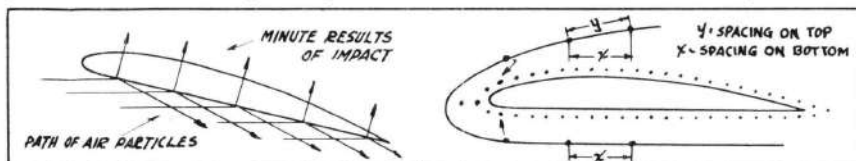
THE NATURE OF AIR FORCES ON WING

Referring to the sketches you will see that a moving and angled airfoil tries to shove the molecules downward. The little fellows will naturally oppose this suppression and will try to push the airfoil upward. If the section is moving slowly, the molecules will take the easy way and try to escape from the pressure in the front and rear of the airfoil. Only the molecules which cannot escape will bear out the law of "to every action there is an equal and opposite reaction." We can make a rough calculation of the molecular reaction under the wing as follows:

Weight of one cubic inch of air is .000775 oz. Our wing area is 200 sq.in. and the speed is 20 m.p.h. Angle of attack is 6° . Using approximate average pressure developed under the wing as shown by the pressure graphs, a 200 sq. in. wing will affect, say, 100 cu.in. or .0775 ozs. of air. The result of multiplying this by 20 m.p.h.² is: $.0775 \times 400 = 31.00$ ozs. of kinetic energy acting at a tangent of 6° . The upward component is $\text{Tangent } 6^\circ = .105 \times 31 = 3.25$ ozs.

This force is obtained by the angle effect of the lower portion. As you will see later, the curve of the upper surface tends to reduce the pressure and lets the atmospheric pressure increase the lift many times. In some cases as much as three times, which would give us 9.75 ozs. of total lift for our 200 sq. in. wing.

(These calculations are necessarily rough. Liberty was taken to use round numbers. The results, which coincide with actual model practice was as surprising to the editor as it must be to you.)



Standard air or atmospheric pressure at the bottom of our air ocean is about 14.7 lbs. or 235 ozs. per sq.in. Therefore, if we only have a 1/8300 pressure reduction on the upper surface of a 200 sq.in. wing, at 20 m.p.h. the atmospheric pressure underneath the wing will surge upward with a power of 6 ozs. Just how do we obtain this heaven sent reduction?

Referring again to the illustration you will note that the distance from the leading edge to the trailing edge is the longest along the upper curve. This means that the upper molecules have to travel a greater distance in the same time as their lower companions to re-meet at the trailing edge. Since the number of molecules on the top is the same as below we can readily see that they will have to spread apart a bit to keep the line contact intact. The moment the pressure is reduced below atmospheric pressure, the reaction from the lower portion makes itself evident in upward surge. We have already noted how small this pressure reduction has to be to work wonders with lift.

The question which always pops up is why we have the greatest difference in pressure at the leading edge, both top and bottom.

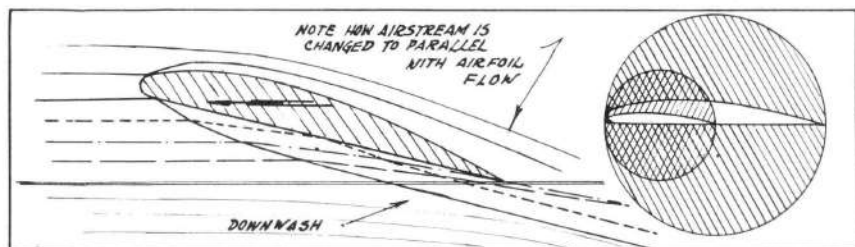
THE EFFECT OF LOWER SURFACE

It is evident that the leading edge is the first portion of the wing which comes in contact with almost stationary molecules. It is at this point that the molecules are initially driven downward, and

in so doing they impart their effect of the minute weight they possess to the support of the plane. This downward movement is evident in flow photographs and is termed "downwash". It changes the angle of the airflow behind the wing which makes it necessary to remember it when designing the size, shape and incidence of the tail surfaces.

This reaction between stationary molecules and moving wing naturally consumes part of the engine power. Since all factors which contribute to consumption of power are termed in the general name of drag, this particular action is called induced drag. The very name 'induced' describes it as something that is brought about by another action. It is not parasite drag which is a waste without visible returns. The induced drag is the result of the law "to every action there is an equal and apposite reaction". This drag or reaction varies as the lift varies. For example, when the lift is small, as at low angles of attack, the downward motion is limited to the nearby neighborhood and thus resulting in low induced drag. While a high lift, which requires high angles of attack, causes the downward motion to extend beyond the neighborhood to backup the upper molecules against the increased oppression. More will be said under "Stall" heading.

The induced drag is a necessary evil. The aviation lads minimize it by decreasing the chord and increasing the span. A glance at the diagram will show that of the two airfoils presented the larger one affects about four times as much air as the lower, although the size of the section is only doubled. Since the span of the smaller airfoil need to be only double of the larger chord for same area, its induced drag will be only $\frac{1}{4}$ the larger. This principle is applied in gliders and whenever permissible on the power planes. It has also led many model builders to follow the example. However, as it will be later pointed out, it is doubtful if this reduction of the induced drag is beneficial at lower speeds where the lift is hard to produce.



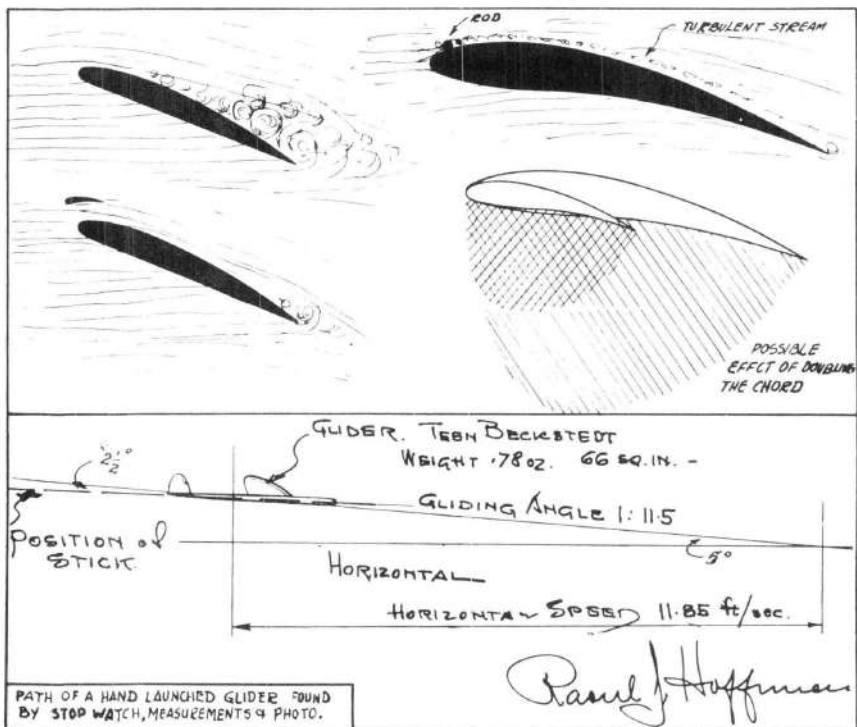
ACTION ON THE UPPER CAMBER

At first thought, we would think that pressure difference would be equal along the entire upper curve. However, we must remember that a substance "gives" most at the point of the initial attack. The "give" or stretch is then transmitted on all sides. On the airfoil, it is the abrupt upward curve which attacks the airflow lines first and it is here that we have the greatest "give" or stretch. We have already seen that the greater the stretch, the greater is the reduction of pressure. This phenomena can easily be demonstrated on a long wire spring on which we can see why there is a greater reduction at high speed than at low. If the spring coil is given a gentle pull, the difference in spacing of the first few turns cannot be noticed. But if the tension is sudden, the increase in spacing is marked mostly at the point of force application. The tension gradually losing its momentum as each and every turn (or molecule) exerts its power of remaining at fixed point.

THE STALL

So far we have covered the ideal manner in which the airfoil works. The end comes as follows: We have seen that the molecules under the wing are given a downward motion. If the angle of attack is small, they will pass the remaining portion of the wing without trying any mischief. But if the angle is increased to such an extent that they are continually forced downward by the angled wing, they will be building up opposing forces all along the lower camber. As they come to the trailing edge, they will try to force themselves upward into area of low pressure. The resultant flow is shown on the diagrams. Their entry produces a circular motion. If the angle of attack is not lowered, this circle will increase its strength and size from the incoming molecules. Soon they will be interfering with the unbroken upper flow as the circling motion opposes the air-line motion. This will slow down the necessary streamline flow until it breaks the first line. Now more dead and useless air is dragged along to interfere with still more upper lines. This process continues until the upper flow is destroyed. Since so much of the lift depends on this reduction of pressure, the result is in complete loss of upper camber help and the plane squashes down in the clutches of gravity. To read on with easy minds, let us assume that the pilot managed to straighten the ship and is again on his course.

The stall treatise will be completed with few remarks on the action of slots to extend the stalling range by clearing away the eddies of stagnant air which break the streamlines. To clear these dead air eddies we must direct against them a strong stream of air. This is done by setting up vanes so that they direct airflow near the surface towards the trailing edge, and so prolonging the period in which the stagnant air does not interfere with the normal streamline flow.

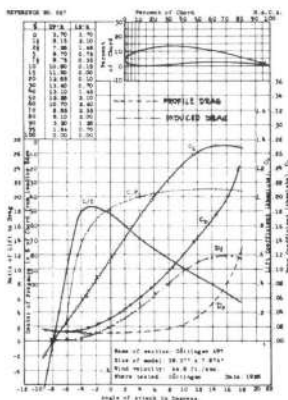


LOW SPEED AERODYNAMICS

Most of the experimental aeronautical data is based on speeds of 40 m.p.h. and upwards to 300 m.p.h. Investigation now in progress are reaching for speeds beyond 300 m.p.h. This cannot be used by model builders. We want information to start from 1 m.p.h. and continue upward to a reasonable extent in accordance with model speeds. A partial answer to this plea is the N.A.C.A. report No. 586 which will be resumed later. To understand this report, we must learn more about the methods used in aviation to compare test model's data with the final product, as well as know the possible difference in reaction, at low and high speeds.

Data appearing in laboratory reports assumes that the airflow around bodies will be similar at all speeds. The only difference being the intensity of the reaction produced by change of speed or velocity. For this reason the only variable in the lift and drag formulas is the speed. The coefficients (indicators of difference in reaction of one body to another, or one angle of attack to another) are found by tests on scale models and applied to full size calculations. It was found that there is a difference in the final results between the model and wing. The full size wing has more lift than the model data indicates. In time this was corrected by adding a correction factor which covered this scale effect.

Indications are now for an explanation of the lift and drag formulas so that we may have a better idea where we may apply our slow speed correction.



LIFT FORMULA

$$\text{Lift (in lbs.)} = C_L \frac{\rho}{2} S V^2$$

DRAG FORMULA

$$\text{Drag (in lbs.)} = C_D \frac{\rho}{2} S V^2$$

C_L = Lift Coefficient
 C_D = Drag Coefficient
 ρ = Density of air .00237
 (at 15°C & 760mm)
 S = Surface area in sq.ft.
 V = Air Speed in Ft. Sec.

EXAMPLE

To find lift and drag of a wing whose area is 8 sq.ft., section G6tt. 497 at 20 pos. Air speed 30mph (29.33 ft.sec.)

$$\text{Lift} = .7 \times .001185 \times 8 \times 29.33^2$$

Ans. 5.208 lbs.

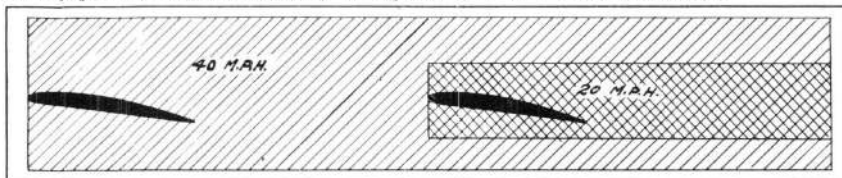
$$\text{Drag} = .045 \times .001185 \times 8 \times 29.33^2$$

Ans. .366 lbs.

The coefficients are, as mentioned above, reaction difference between different bodies and angle of attacks. Density of air is an indicator of the number of molecules in a given volume of air where the plane flies. It thins with increase of altitude. Its inclusion in the formula automaticallk takes care of these changes, since the number of molecules will be smaller with increase of altitude.

The wing area is evidently the factor which controls the amount of air acted upon. The speed, which is squared, determines the number of molecules which will be attacked within a given time. As we have seen in the first section, it is very important to attack the molecules suddenly and give them no chance to escape in a round-about-way.

About the squaring of speed: As a rule we just take it for granted without worrying about the reasons behind it. And because of this attitude, it is more or less a mystery to those of us who have forgotten physics. The square law can be developed from a series of motion and kinetic energy formulas, but the simplest explanation is as follows: A plane travels at 20 m.p.h. and another at 40 m.p.h. Logically we would think that we are affecting only twice as much air, judging by the distance travelled. The point we neglected to bring in is that when we travel twice as fast we also attack the molecules twice as hard, and so affecting twice as much air below and above the wing. We now have; twice the distance travelled and twice the downward and upward effect. Results: Four times more reaction at 40 m.p.h. than at 20 m.p.h. See diagram for visual explanation. Of course, we are not getting anything for nothing as the drag is also squared with doubling of speed for the same reasons.



REACTIONS AT LOW SPEEDS

The question is if these statements hold true at speeds below those at which the tests were made, 40 m.p.h. or so. It might be safe to surmise that at low speeds the molecules do not react according to the square law because the airfoil is evidently sluggish and action of short duration, (small chord) to make worthwhile impression on the molecules. It can be likened to a bicycle pump. If the handle is shoved down fast the air is forced into the inner tube, but if it is pushed slowly the air manages to ooze out between the plunger and the piston wall. Could it be that this is what happens at low speeds? Our job, therefore, during the coming months will be to prove or disprove these formulas. The coefficients will undoubtedly be changed. At 40 m.p.h. the air molecules react strongly and develop increased and decreased pressures as stated. The assumption that they will react in like manner at 20 m.p.h. minus the square effect or to only $\frac{1}{4}$ value is the point in question. Experiments tend to show that we cannot use the assumption of equal relative values. More about this in the Report 586.

DRAG AT LOW SPEEDS

So far we have surmised that at low speeds the air is sluggish and thereby interfering with the "stretching" upper streamline lines as well as giving poor returns on pure reaction differences. The drag also suffers, or should we say rejoices, because of these characteristics. Take the shearing action for an example. As the leading edge plows into our three dimensional web it has to tear the molecules apart. If it is done slowly their resistance is great, but do it fast and the molecules are apart before they realize what has happened. It is like tearing a rag. Do it slowly and the cloth will bunch, stretch and tear in all direction. But tear it fast and the result is a clean tear line. This plowing into molecules at low speeds is like trying to get a start; a perpetual initial attempt to overcome the stationary molecules. While at high speeds the molecules are given the impulse to move up or down a considerable distance ahead of the leading edge. So, here again the coefficient of drag might be much higher for low speeds than that given for higher speeds because of this initial inability of the section to obtain a start.

Still another drag to worry about at low speeds is the skin friction. It is thought that this might have something to do with early stalls at low speeds. With air molecules so minute that they could hold a political meeting on a pin point, we can reason that we carry a great many of them in small cracks, crevices and lean-tos formed by balsa and paper fibers. All would be well if these molecules were selfish and just filled up the pores. But no, they believe in cooperation and stick out their tenacles for other molecules to hold on for a free ride. By now we have a cluster like a swarm of bees to drag along during the flight.

The results are not proportionate to the square law at high and low speeds. At high speeds we manage to clear this cluster almost to the skin and give the lodged molecules very little chance to lend a helping hand outward beyond the surface. While at low speeds the cluster has time to accumulate as there is plenty of time to catch a hold. It is like riding a crowded street car. While the car is moving slow, people have time to catch the smallest holds and brace against steps. While at high speeds it is hard to coordinate this catch, and if successful, the air pressure or wind tends to tear them from the hold. This picture gives an idea of the boundary layer at low and high speeds.

ASPECT RATIO AT LOW SPEEDS

It has been shown that the induced drag varies with Aspect Ratio and that this fact is used by full size plane designers. The question is; how will this work at model speeds. It was made evident that the lower surface of the wing contributes a great deal of lift at low speeds. Therefore, it would be advantageous to favor it by having large chords. In fact, the induced drag theory might work hand in hand at low speeds. It might not be beyond imagination to expect a chord of double size to effect four times as much air. See sketch for thought behind it. And with air being so stagnant at our speeds, it might be to our advantage to react upon it as long as possible. Since most of the drag is usually contributed by the rest of the model, a slight increase of wing drag in return for more lift at lower angle of attacks is a worthwhile exchange. However, if you have area to spare, use high aspect ratio.

To have fair torque and stability control it does not seem advisable to have aspect ratio of below 6-1. The importance of well-designed tips cannot be overemphasized at low aspect ratio. What we may gain by having large chord, we might loose through poor tips. A safe rule to follow is to use elliptical tips which have their minor axis begin at about two chords' length from the tip. The outline need not follow the ellipse to the letter, according to Mr. Hoffman, but it maybe of parabolic nature, which is almost identical except that the tip portion is wider. This recalls the recommendations we made last year of not having the tips of smaller size than $3\frac{1}{2}$ in. as measured by the continuation of taper lines to the tip chord line. The previous discussions bear out this thought. Just remember, the smaller the airfoil, the less effective it is.

A final word on the Aspect Ratio has to do with the shape of air foils towards the tip. The airfoil with a large trailing edge droop develops considerable high pressure under the lower camber. So to carry out full efficiency to the very tip we must gradually drop this pressure by changing the downward droop to a gradual streamline at the tip. Luckily the low speed sections lend themselves to trailing edge tapering without necessitating individual plotting.

Resume of

National Advisory Committee for Aeronautics

Report No. 586

AIRFOIL SECTION CHARACTERISTICS AS AFFECTED
BY VARIATIONS OF THE REYNOLDS NUMBER

By Eastman N. Jacobs and Albert Sherman

(As interpreted by your editor)

The object of the investigation was to make available section characteristics at any free-air value. Therefore, when data from a model test are applied to a full size airplane, the flow conditions would be similar in both cases. This is necessary since the aerodynamic coefficients usually vary with change in the Reynolds Number, (the ratio of the mass force to viscous force, usually referred to as "scale effect".) Mass is weight of air divided by gravity constant (32 ft./sec.^2), and viscosity is the force with which the air molecules cling together. Molasses has high viscosity, alcohol, small.

Early tests were made in small open-to-air tunnels which made it impossible to cover a large range of Reynolds Numbers needed to bridge the gap between 5 x 30 inch model and 7 x 50 foot wing. The requirements being that the model should be attacked by the same number of molecules as the full size wing at the same instant. This means high compression, or close spacing of the molecules, of the air which runs in the wind-tunnel.

The N.A.C.A. variable density wind-tunnel is a unit all enclosed in an elongated tank made of about $1\frac{1}{2}$ inch steel plates. Powerful pumps can compress the air contained in it to pressures of 20 atmospheres, or $14.7 \text{ lbs./sq.in.} \times 20 = 294 \text{ pounds per sq. in.}$ This increases the molecular contents 20 times, or having a 5" chord equal 100" (almost $8\frac{1}{2}$ ft.) under normal atmospheric conditions. This tremendous pressure is used to simulate full size conditions for a large range of Reynolds Numbers. To test for Reynolds Numbers below the 40 m.p.h. flight speed but still retain this speed for wind-tunnel work, the pressure was reduced as low as $\frac{1}{4}$ normal atmosphere or 3.9 lbs./sq.in. , or reducing the number of molecules to a number which would correspond to the number which affects the wing at lower flight speeds.

The standard 5 x 30 inch test models were made of metal, usually of duralumin and very highly polished. They were repolished after every run. The airfoils used were those developed by the N.A.C.A. Luckily, some of them look good for model work. (In fact, J.P. Glass recommended some of them for model use in 1936, and they were included in the 1935-36 YEAR BOOK.)

The accuracy of these tests is as fine as modern engineering permits. Every care and correction factor was applied during the run. However, the results, especially the drag and pitching moments under 800,000 Reynolds Number became relatively inaccurate owing to the limitations imposed by the sensitivity of the measuring equipment. (The equipment is very accurate and sensitive when under normal fairly high load.) "In fact, it appears that the accuracy becomes insufficient to define with certainty the shape of curves representing variations of these quantities with angle of attack or lift coefficients. Hence, the airfoil characteristics dependent on the shape of such curves, that is, the optimum (best), lift coeffi-

"Flight conditions as regards the effects of the transition may then be considered as being approximately reproduced, but it should be remembered that the flow at the lower Reynolds Number cannot exactly reproduce the corresponding flow in flight. Both the laminar and turbulent boundary layers are relatively thicker than those truly corresponding to flight, and both boundary layers have higher skin-friction coefficients at the lower Reynolds Number".

The maximum lift coefficient is one of the most important properties of the airfoils. It determines the maximum lift of a wing as well as its stalling speed. As can be seen from the graphs, this maximum lift coefficient varies greatly with Reynolds Number because it is dependent on the boundary-layer behaviour, which in turn is directly a function of viscosity as indicated by the value of the Reynolds Number.

"The mechanism of the stall as affected by variations of Reynolds Number: Basically, the discussion is concerned mainly with the air-flow separation. The pressure distribution over the upper surface at the maximum coefficients is characterized by low-pressure point at a small distance behind the leading edge and by increasing pressure from this point in the direction of flow to the trailing edge. Under these conditions the reduced-energy air in the boundary layer may fail to progress against the pressure differences. When this air (next to boundary layer) fails to progress along the surface it accumulates. The accumulating air thereby produces separation of the main flow. The separation, of course reduces lift."

As it was pointed out in the first section, the reduction of pressure on the upper camber depends in having an unbroken airflow from the leading edge back. We have just been told that at low Reynolds Number the separation of this flow away from the airfoil happens at very small angles of attack. A visual proof is given in the first photograph. Although the flow seems good, the break away has happened as it can be determined by the fact that the flow lines above the airfoil are almost straight back. While the second photo, taken at higher speeds or Reynolds Number, also shows separation, we still have lift as can be seen by the curved lines over the airfoil. The third photo shows a fully developed stall. Note particularly the tear away of air at the leading edge, and the eddying of air from the lower high pressure portion. The black space is dead air being dragged along, and it just contributes so much more drag.

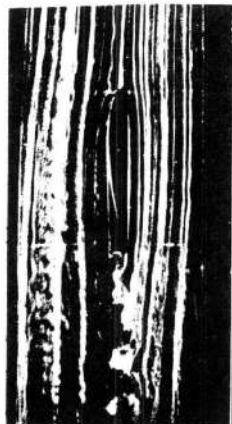


Photo 29 Separation occurring on an airfoil at a low angle of attack.

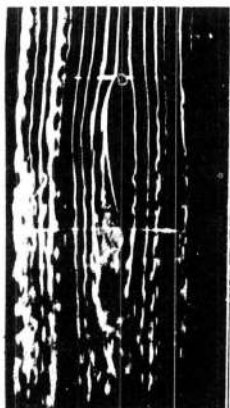


Photo 30 Separation occurring on an airfoil at a low angle of attack, fig. 2 at an increased Reynolds Number.

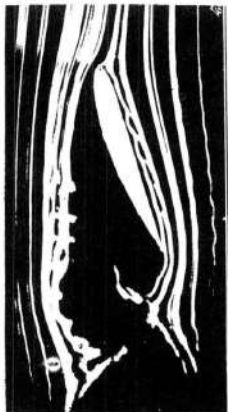


Photo 31 Separation occurring on an airfoil at a high angle of attack.

"The process of stalling, in general, is more complex than just discussed. It has been compared by Jones to a contest between laminar separation near the nose and the turbulence separation near the trailing edge, one or other winning and thus producing the stall." (Or it might be a combination of both.)

From this we can see that boundary layer plays a great role at lower speeds. This would indicate that the upper portion of the leading edge is most important. We would be led to believe that it should be highly polished to reduce the boundary layer, yet an experiment made by Mr. Jacobs would prove just the contrary.

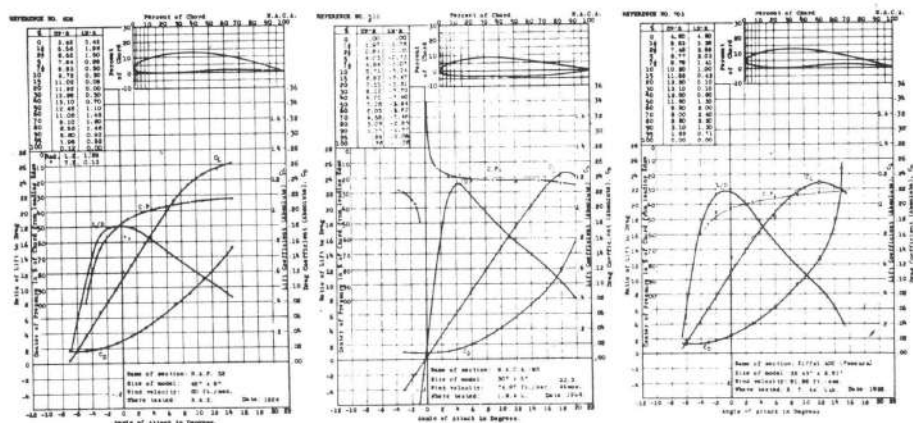
(This experiment was mostly of an illustrative nature. It will very likely not appear in print. We managed to hear of it because of a personal visit to the Langley Field N.A.C.A. Laboratories.)

While testing a series of 12 inch chord airfoils closely resembling the standard sections now used in models, it was found that the lift developed by the upper camber was practically zero as shown by the first photograph. Differences in thickness, upper and lower camber did not seem to make any change in the flow. Seeing the separation taking place at zero angle of attack, Mr. Jacobs thought of placing a 1/8" diameter rod a short distance behind the leading edge. The idea being to produce a turbulent flow with which to combat turbulent boundary layer. It is a known fact that a turbulent flow displays much more resistance to separation than the laminar or smooth flow. The experiment worked like a charm and the sections followed the action similar to that of high Reynolds Number.

It might also be mentioned that the above airfoils were made like model wings. One airfoil did show better characteristics. A close inspection later on showed that this particular airfoil had its leading edge spar form a sharp break with the covering, and so producing the turbulent flow which Mr. Jacobs later reproduced in other airfoils with the rod.

This then is a condensed version of the N.A.C.A. Report No. 586. The editor has taken rather wide interpretation liberties at certain points. It is hoped that he was correct in conveying the original meaning, and that the authors would recognize it as their work. The report can be obtained for fifteen cents from the Superintendent of Documents, Government Printing Office, Washington, D.C.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS AERODYNAMIC CHARACTERISTICS OF AIRFOILS



THE SELECTION OF AIRFOILS

The discussion on the low speed aerodynamics presented a dark picture for us. And if we were not already flying models and getting fairly good results some of us would become discouraged. To be perfectly frank, we must admit that our models are not such wonderful performers when compared with full size ships. Our biggest stock in trade is the high power we use to literally pull the models up regardless of their aerodynamic efficiency. Some of us get a lucky break to catch a thermal and we reflect in the work done by nature. How often have we seen a model practically point down yet being sucked into the clouds! Those 15-1 glides some boys report must be optical illusions as it is only necessary to do a bit of calculating. If a model achieves 300 feet and its speed is 10 m.p.h. and the glide is 15-1, it should take at least 5 minutes to reach the ground. While normal average flights are within 2 and 4 minutes duration, we can readily come to the conclusion that the average gliding ratio is about 7-1. This sounds reasonable. Gas models, on the other hand, with their larger airfoils, are beginning to show us just how a model should be flying.

Last year a series of gliding tests were made on five wing sections. The work was done in the stillness of an armory. The area of the wings was 150 sq. in., round tips, aspect ratio of 6-1, and with every wing having the same C.G. point and weight. Admittedly, these tests were not conducted with laboratory precision, but normal model practice was applied. Wing loading was about 2 oz. per 100sq.in. The test fuselage was solid balsa sheet with balsa tail surfaces. The adjustments were made by changing the angle and applying weight in form of modelling clay. Out of the series the Clark Y had the best gliding angle with a ratio of 6.5 to 1. The next in line was the RAF 32 with slightly less. A Clark Y top with single surface undercamber showed up third with about 5.5. to 1. M-6 showed 5-1 after needed incidence was applied. Another section of extremely deep undercamber at the trailing edge was tried. This section was too unstable with the small stabilizer. It was very sensitive with tendencies to gallop. The glides were timed and Clark Y had the best duration.

The above tests might not prove anything as increase of wing loading and higher speeds would have shown different characteristics. It proved, however, that the reaction at low speed is not in proportion to the higher speeds. The performance of Clark Y in comparison with RAF 32 type was a surprise. It is quite possible that the RAF's undercamber provided diving moments which are normally taken care of in practice with large stabilizers and shifting the wing until the balancing point is reached. While the testing fuselage had fixed mount and small tail. However, the fact that deeply undercambered sections did have strong diving moments would prove that the undercamber is very effective at low speeds.

While abroad, the oversea lads wanted to know the secret of American phenomenal durations. The answer was: "Use a large dihedral, a large tail, large prop, plenty of power, a weak mind and strong arm when you wind to the maximum, launch and pray". This formula has undoubtedly won most of the contests and it will still keep on doing it. The idea, of course, being to get the model as high as possible and hope for thermals. Yet even following this formula we run into trouble. Sometimes the currents simply are not there and we must admit that as a rule the glide of a model is pretty poor. We only need to compare it to the soarers which never seem to come down when they attempt to land.

The large gas models need not worry about efficiency of their wings outside of their stability viewpoint. They have sufficient power in the 10 c.c. to tide them over the tight spots, as well as produce 'power pull-ups'. The field in which we should be most concerned is the 500 sq. in. and under. And with introduction of smaller and lower power gasoline motors, the gas model builders will be in the same lot as the rubber powered boys.

From the information gathered from the low speed visualizations, our guess, which is as good as yours, would be to use airfoils which have the leading or entry edge of almost neutral characteristics, just as though the airfoil was set at 0° angle of attack. This should provide a good initial airflow with small drag values. Since the upper flow breaks away so soon at low speeds (pending further investigation of the Jacobs' turbulent rod) it would seem best to pay more attention to the lower camber. Referring to Figure 23 airfoil, with flap

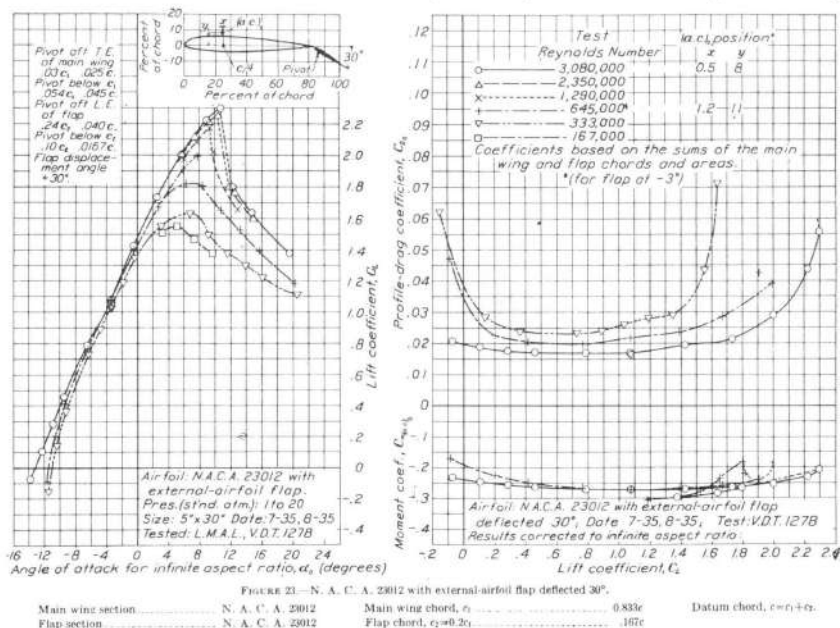


FIGURE 23.—N. A. C. A. 23012 with external-airfoil flap deflected 30° .

Main wing section: N. A. C. A. 23012 Main wing chord, c 0.835c Datum chord, $c=c_1+c_2$
 Flap section: N. A. C. A. 23012 Flap chord, $c_2=0.20c$.167c

set at 30° , the plotted results show very good values of lift without increasing the drag beyond uselessness of the section. Of course the diving moment, or bringing of the Center of Pressure to the rear are great. But since we use large stabilizers this should not worry us very much after satisfactory flight and glide adjustments are made. Therefore, a good airfoil should embody this downward droop of the trailing edge. Perhaps more light will be shed on the subject by inclusion of a report sent by one of our correspondents, Robert Hawkins.

"Mr. Sullivan, Aeronautical Professor at Indiana Tech, put me next to an idea of using the complete planform of a section then dropping the rear 40% of Chord about ten degrees. The effect is that of a 40% flap permanently depressed ten degrees. The N.A.C.A. claimed at a SAE meeting that the glide was increased, the stalling point remaining the same, and the lift increased all out of proportion to the drag increase. See sketch for method used. Note that the 'bend' is carefully faired into the airfoil. Now, here is what I don't know about. Does the angle of attack used at Langley Field tests include the drop of the chord line or is it figured on the original line? If

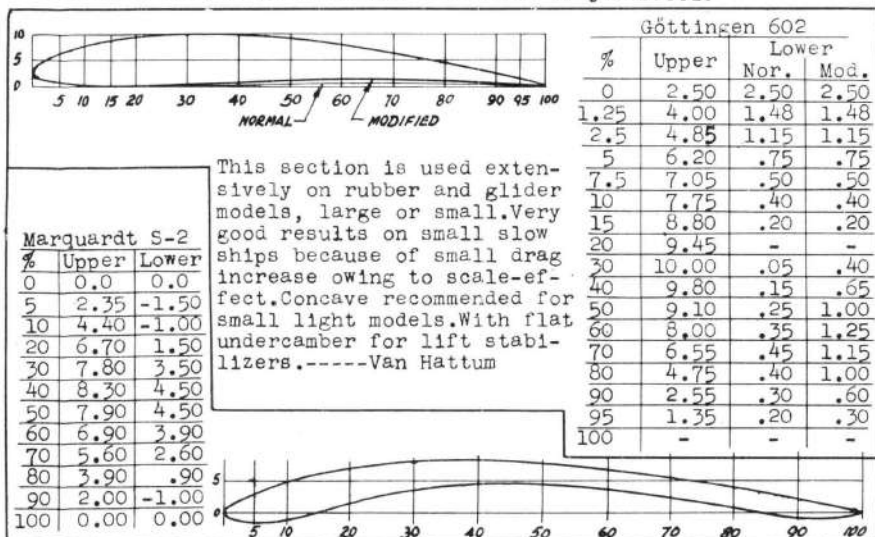
the new chord line is used, you have what we could consider a sort of a glorified R F 82, which makes one wonder whether its a 'find' or merely 'one of those things'. The Center of Pressure moves to the rear as the flap or bend is depressed, but remains almost constant through the range of lift."

Reports from the field favor undercambered sections. Results from airfoils of Marquardt and Ritzenthaler designs proved very good in actual use. Marquardt airfoil is shown somewhere in the book. If these airfoils are set at a few degrees positive angle of attack, they would almost meet the specifications we have just mentioned. We might also recall that birds' wing section closely resemble this design. And Mr. Raul Hoffman mentions this close relation in May, 1938 issue of Popular Aviation. Since bird flight is very similar to model, we can be fairly assured that we are on the right track with our assumptions. Also see Lippisch airfoil design on Page 128. Mr. Lippisch knows his aerodynamics since he has been in the game from the very beginning so that we can safely use his design.

Referring to the N.A.C.A. Airfoil 8412 we will note that it also meets the qualifications if it is set at about 5° . In fact, Mr. Jacobs recommends this section for model use. It has all the needed features, thickness for spar depth, trailing edge adaptable for tip tapering and Reynolds Number tests to 41,000. It can be thinned if you wish to experiment; just change the thickness ordinates.

The interesting experiment tried by Mr. Jacobs to produce a turbulent airflow should be a welcome test for the wings now being flown. It just needs cementing of 1/8 dia. rods on some point near the leading edge. The exact point seems to be important, so make several trials. This idea might be carried on all surfaces. Reports would be most welcomed and we are sure Mr. Jacobs would like to know how his stunt works in practice.

With so many doubts in our minds it is difficult to make any other airfoil suggestions. It is true that we have contradictions right and left but this is because we do not yet have sufficient correct data to be certain. Since we have a vague idea what it is all about we must present as many possible points for discussion. If it has only made you to realize how little is known about low speeds, the inclusion of this chapter in the book will be justified.

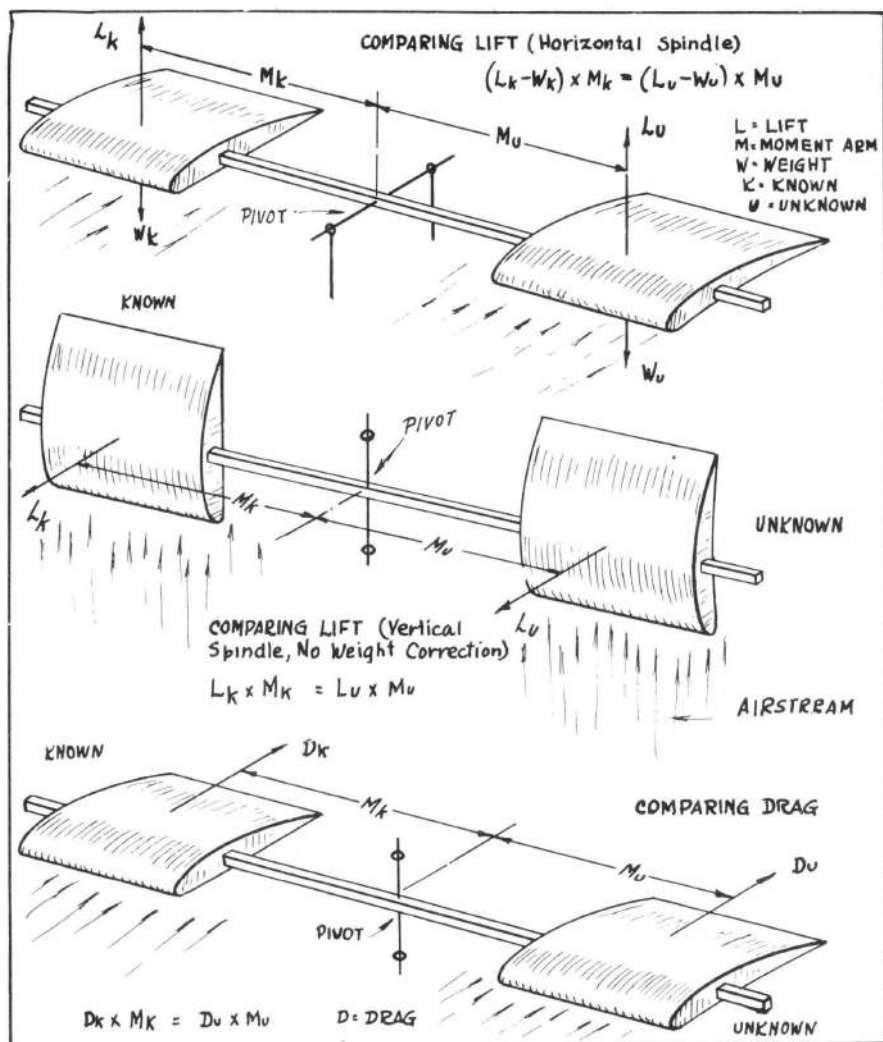


AEROBALANCE

by A.G.Nymeyer

The idea of the aerobalance suddenly arose in my mind when I was experimenting with my new airfoils. I believe it is quite new, at all events, I have never seen any means of comparing airfoils built like this.

It can be easily built from very few and cheap parts. To obtain good results it is only necessary to have good bearings and an airfoil whose characteristics are absolutely known. I use the well known airfoil, the Göttingen 497 which has been used very much in Europe and of whose characteristics are well known even at low speeds. The testing procedure is as follows:



The test sections are of six inches span and chord. Both the known and unknown wings are placed on the balance arms of the Aero-balance. The Göttingen profile is fixed at a certain distance from the center and all characteristics noted, such as angle of attack and its C.G. point. The unknown is similarly positioned, following as close as possible the master wing settings. The AEROBALANCE is now placed in some sort of an airstream.

The small size of the balance makes it possible to use an electric fan. A better flow can be obtained by using a four-bladed propeller. If these means are lacking, the natural wind can be used as knowing the speed is not important since both airfoils have identical speed. Of course, the set up can be complicated with a regular set up of honeycombs, controlled air and speed of the electric motor revolutions. The readings are taken as follows:

After the balance has been under the wind influence for a sufficient length of time to be certain of its action, the calculations are made. Say, for example, that the unknown airfoil had an upward motion which indicated greater lift than the master airfoil. We must now shorten its arm until both sections are in balance. The equation presented then is:

$$\text{Lift of known Airfoil} \times \text{its moment arm} = \text{Lift of unknown Airfoil} \times \text{its moment arm}$$

$$\text{Or } L_k \times M_k = L_u \times M_u$$

The only unknown or X, will be the Lift of the unknown wing. All other factors are known or can be measured. However, this equation does not take care of the difference in weight of the balance halves as the sections are moved for counterbalance, and so moving the C.G. The corrected diagram is shown in the sketches.

To eliminate all weight factors the AEROBALANCE can be placed into a vertical airstream, and since the weight of the various parts is at right angles to the lift we can forget the weight in the calculations. The drag force can be found on the horizontal airflow as here the drag force is at right angle to the weight forces.

The method just disclosed to compare aerodynamic characteristics of different airfoils can be applied to many other objects, such as fuselages shapes. It can be modified to meet a great many conditions.

EDITOR'S NOTE: Mr. Nymeyer has provided us with a new method of trying out our ideas. The idea can be very helpful in deciding which section to use. It is unfortunate that we do not have more characteristics of the section he mentioned besides those listed in the Report shown elsewhere in the book. Offhand, the square planform seems a bit on the doubtful side, although the six inch chord is a good size to use. One difficulty in using large spans is that we move out of the current sphere as produced by an ordinary electric fan. Perhaps some of you can make larger airflow supply, or wish to test outdoors. Let us, therefore, standardize on the following:

Use Clark Y as the Master Airfoil. Dimensions 5" Chord, 15" Span with round tips. This wing will have an area of 70 sq.in. with an Aspect Ratio of 4.5 to 1. This section should show up the difference between flat and undercambered lower surfaces. If tests are made in a steady stream, the lift of the Clark Y can be found by placing weight on the opposite arm at the point which is the same distance from center as the Clark Y's C.G. Of course, it is understood that the balance will be balanced before the tests are begun.

There is no limit to the applications of this device. It is hoped that great many of us will try it and have concrete information by next year. If all of us were to wait for the other fellow to do the experimental work we would never make any progress towards a better understanding of Low Speed Aerodynamics.

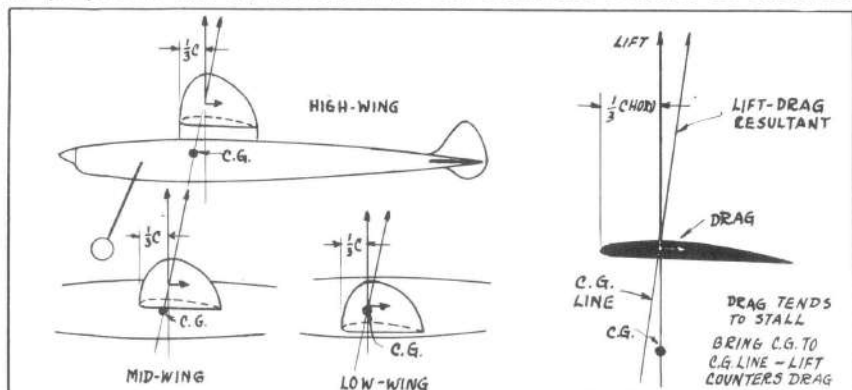
STABILITY

With introduction of higher speeds to meet higher wing loading, and the universal adoption of the gasoline motors, our stability problems are growing because speed is one force which shows up the slightest defects, no matter be it man or machine. The model has three dimensional possibilities and its stability becomes more complex than that of a two dimensional vehicle such as an automobile or boat.

There are three classes of stability: Longitudinal, or up and down. Directional, or right and left. Rolling, or changing the position of the wing with respect to the horizon. Although all three work in cooperation, the last two are almost always used in combination.

LONGITUDINAL STABILITY

Longitudinal or up and down stability is required because the lifting force of the wing does not stay fixed with change in airflow or angle of attack. It is basically dependent on the position of the C.G. in relation to the lift resultant. Discounting the effects of the propeller and thrust line, we can stabilize a model as sketched.



Most of the adjusting directions mention the position of the C.G. at $\frac{1}{3}$ Chord behind the leading edge. Yet when this is done the model still stalls. The reasons are sketched. Note that besides having a lift we also have a drag force to counteract if the C.G. is placed directly below the lift force. The drag force tends to stall the model, and if the stabilizer is not able to counteract it, the model will be unstable. As you all well remember after you have placed the C.G. at the $\frac{1}{3}$ point you still had to push the wing back so that the C.G. counteracted both the lift and the drag moment. Just how much should we move the C.G. forward to balance both forces? The simplest trick is to take the resultant formed by the lift and drag, and extend it through the model. The C.G. can be placed anywhere along this line with assurance that it will be correctly positioned.

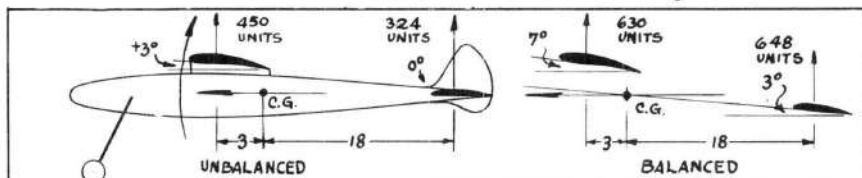
To obtain the correct resultant angle we must know the forces acting on the lift and drag lines, as well as the point through which it acts, or the Center of Pressure. Judging from experience it would seem that the L/D of a wing is about 8 at the angles of attack we use 4° to 7° . The Center of Pressure is between 30 and 40% Chord. This information provides us with a rough means of computing the place and the angle of the resultant so that we can estimate the line on which the C.G. should be located for the simplest and the best method of achieving longitudinal stability.

This type of stability is used in the regular aircraft designing. Its value lies in the fact that we have no load on the stabilizer, and the moment the wing wanders away from its setting without manual control, the stabilizer effect is almost immediate. The designs that require a load, up or down, on the stabilizer, are always tricky since we cannot be sure of how the stabilizer will react.

This method of achieving longitudinal stability can be easily applied to gas models where the weight is concentrated on the nose. The resultant line should be known, and if possible marked on the fuselage. When a model misbehaves you can always begin the checking by starting with the C.G. position.

The stability diagram evolved for rubber models during the last three years is as illustrated. This is the outcome of bringing the wing forward and using a large lifting tail to balance the upward tendency of the wing force. Note that the C.G. is almost at the trailing edge of the wing. The design is definitely of semi-tandem pattern, and if we make a few calculations you will see that we can treat it as such.

In the AERODYNAMICS section we have been shown that we have downwash. We do not know its angle at low speeds but we can assume 1° . This would set the actual airflow for the stabilizer at 1° less than set by the base line. We can also realize that the air is fairly well mixed up by the time it reaches the stabilizer so that we cannot expect it to be 100% efficient; 75% efficiency is a fair estimate. Remembering these conditions we can go ahead and make few calculations to familiarize ourselves with the action of a lifting tail.



With the wing lift ahead of the C.G. it is evident that this force will try to stall the model unless we have a counterlift on the tail end. Just at what angle will the wing and tail forces balance each other? Let us take for an example a model using a 200 sq. in. wing, 80 sq. in. stabilizer, Gottingen 497 for wing, and Clark Y for stabilizer, 8° incidence (about $1/8$ " blocking for 5" chord) on wing and 0° on stabilizer. Wing's moment arm is 3" and stabilizer's is 18".

To simplify calculations we will use standard coefficients, areas and moment arms. We could use the regular formulas but since speed and air density will be same for both surfaces, we can leave them out. Because the tail is only 75% effective we have an effective stabilizer area of 60 sq. in. Because of 1° downwash, the angular difference between the wing and stabilizer is 4° . Therefore:

Results for wing at 3° $200 \text{ sq. in.} \times .75 \text{ (coef.)} \times 3" = 450 \text{ units}$

Results for tail at -1° $60 \text{ sq. in.} \times .3 \text{ (coef.)} \times 18" = 324 \text{ units}$

Under these conditions the wing will obviously lift the front into a larger angle of attack until a balance of forces is achieved, as:

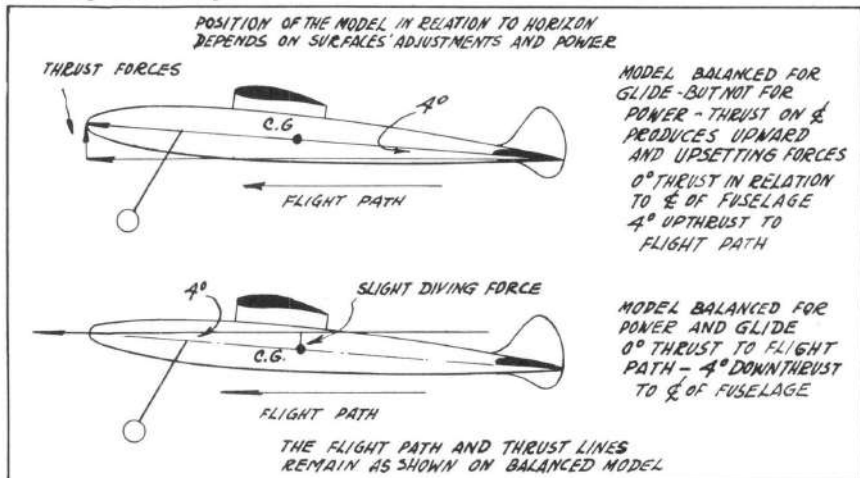
Results for wing at 7° $200 \text{ sq. in.} \times 1.05 \text{ (coef.)} \times 3" = 630 \text{ units}$

Results for tail at 3° $60 \text{ sq. in.} \times .6 \text{ (coef.)} \times 18" = 648 \text{ units}$

The balance is now in effect with stabilizer in favor. These calculations come very close to observed performance, especially the 7° angle of attack. Mr. R. Hoffman made extensive experiments on hand launched gliders and he found that 6° was a good average. Having the C.G. further back on rubber models we can concede the 7° .

If the weight of our test model is 8 ozs., the above proportion of moment arms indicate that the wing lifts about $6\frac{1}{2}$ ozs. and the stabilizer $1\frac{1}{2}$ ozs. This equation or aerodynamic balance will hold true at all speeds. Speed, not including the effects of thrust line, has no effect on the balance. It is evident that since both surfaces have the same speed they must have the same proportionate reaction. The change of speeds, as it will be cleared up in the POWER chapter, determines the flight path in relation to the horizontal line. While the aerodynamic longitudinal balance determines the position of model in relation to the airflow. In our case, discounting torque and assuming head-on flight, the base line or fuselage center line would be 4° positive in relation to the flight path. See sketch.

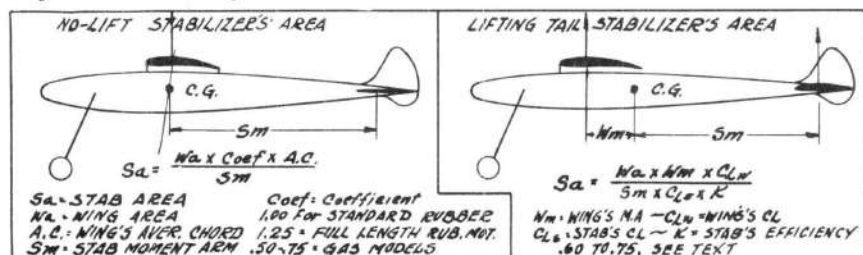
The modern method of adjusting rubber and gas models is to first adjust for the best glide, and then for the power climb. The glide adjustments are usually made by moving surfaces back and forth, increasing incidences and moving or adding weight. The final setting result is the aerodynamic balance of the tandem set-up just covered, or the positioning of the C.G. on the Lift-Drag resultant line. The power climb is controlled by shifting the thrust line until best results are obtained. Why must the thrust line be shifted to provide climbing stability?



Referring to the diagrams: If the Thrust Line is passed through the C.G., the moments about the C.G. seem to be satisfied at a glance. But if we were to work out the thrust diagram on the assumption that the model is set at angle of attack of 4° we will note an upward component of thrust which tends to nose the model upward. (In experience this is illustrated by the fact that most models stall under power until down thrust is applied.) Checking on the down thrust used we note that model builders use anywhere from $1/32"$ to $1/8"$ down blocking on $1\frac{1}{2}"$ dia. or height of nose plugs. In angles this varies from 1° to 5° . The 5° is most applicable to the 200 sq. in. model we are checking. If we draw this 5° down thrust line in reference to the base or center line of the fuselage we will note that thrust is now almost parallel with the flight path. The upward thrust component is lost and we have slight downward effect. However, we assumed about the maximum downthrust used in practice 3° or 4° is more like what we actually use. A 4° downthrust would balance the upward component. While a 3° downthrust would still produce a small upward force. However, its value is comparatively small and it can be easily controlled by the general aerodynamic balance.

We have cleared up the upward or upsetting thrust component by changing the thrust line. But we now have a thrust force line passing about 1" above the C.G. tending to dive the model. The power of this force can be roughly estimated from the L/D characteristics of the model. If our 8 oz. model has such excellent L/D as 8 to 1, the drag would be 1 oz. This drag requires 1 oz. of thrust for level flight. Therefore our diving force is 1 in./oz. This diving force is easily balanced by the slight upward component force at the nose. Since increase or decrease in thrust effects both forces equally, our balance is assured. This accounts for the final fine adjustments we all make with down thrust.

From the description given, it would seem advisable to keep to non-lifting tails on gas jobs, which is understood to be the positioning of the C.G. along the Lift-Drag Resultant line. Using lifting airfoils on the stabilizer with the C.G. so positioned that they do not develop any special dangerous characteristics. In fact, it could be used to compensate the thrust line if it is under the C.G. However, the airfoil effect should be slight or the stabilizer will assume the upper hand since it has such an enormous moment arm advantage over the wing.



The formula for finding an approximate non-lifting tail area is given in the diagram. Note that we have coefficients to justify for different designs. Rubber models must naturally have larger stabilizers since the motor weight is distributed along the fuselage and the wing so far back. While gasoline models have the wing so far forward that we can minimize the effect of inertia caused by swinging fuselages. It requires more power to stop the swinging of a long beam than short one, even if both are of same weight. It might be mentioned that the formula is simply a check. You may use more or less area than the formula produces. A smaller area requires finer adjustments, while a large area tail gives fair results with rougher adjustments. In aviation, the tail size is kept as small as possible to cut down the drag.

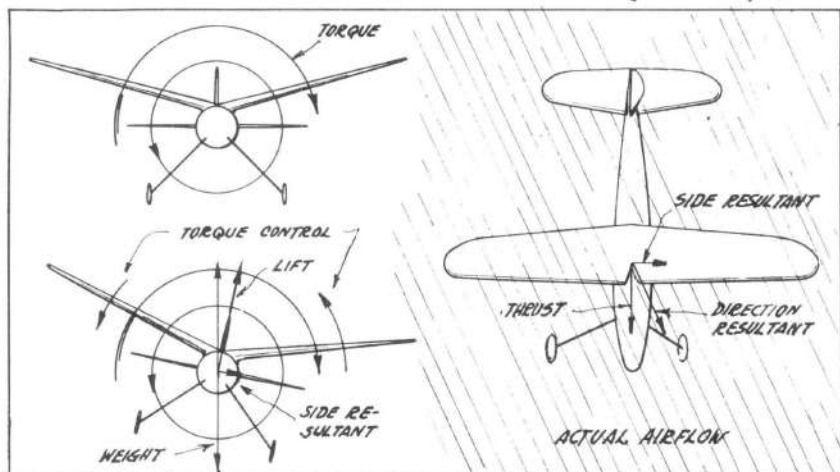
Although a lifting stabilizer is not the ideal stabilizing medium, we are forced to use it on our rubber models. So, we might as well know how to get the most out of them. When using a lifting tail the first concern is to make sure that the wing stalls before the tail if something unusual happens. The very fact that the tail works at 4° angle of attack less than the wing should be of some consolation. However, we must not forget the lifting characteristics at low speeds. We can keep the efficiency of the stabilizer high by using double rudders. This has the effect of increasing the Aspect Ratio or reducing the tip losses without increasing the span. Also, when the airflow is from a side the blanketing of the stabilizer and rudder area is less when the rudder is divided into two portions. Another stunt is to use fairly low aspect ratio to keep the stabilizer's Reynolds Number comparable to wing. In all, try to make it as efficient as you can without increasing the angle of attack differences between wing and stabilizer.

SPIRAL STABILITY

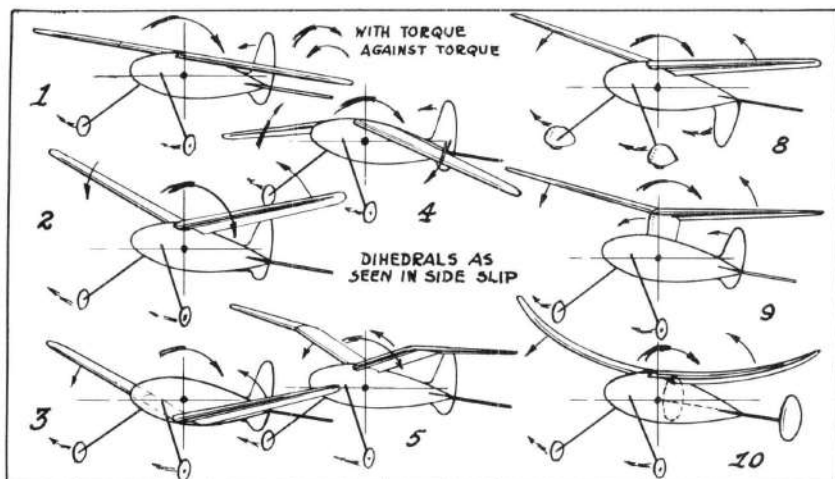
Spiral stability is a combination of Directional and Rolling Stability. It was discussed in great length in 1937, but models are still spinning in 1938 so that some of us must still have vague ideas about the matter.

We cannot avoid making spirally unstable models every once in a while, and most of us have sufficient adjusting experience to obtain some sort of flights from such models. However, we find considerable trouble attached to them as every adjustment we make only seems to hold for that particular power. They might fly fairly good under low power or calm weather, but as soon as we pile on turns or try to fly in rough weather we run into trouble again. This is a sharp comparison against a stable model which seems to possess miraculous power of adjusting itself to all sorts of weather and power conditions. Just what is the difference between a stable and unstable design? For the answer we must review the action of the model while under influence of airflows which effect the model from sides, just as we did for the Longitudinal Stability which depended on the airflow along the flight path.

Offhand, we are led to believe that a model flies with the fuselage parallel with the airstream. Very likely, this idea has led us to minimize the importance of stability required to keep the model in control while side forces are trying to throw the model out of course. One of the basic forces which we have to keep under control is the propeller torque. The torque will react against the fuselage and try to rotate the model in a direction opposite of the prop rotation. The moment this force is applied, the lift component of the wing is no longer vertical, but at an angle. In the head-on view the result is a side force trying to pull the model away from the flight path. A plan view of the forces would show us this force plus the thrust force. Since both are pulling at angles to each other we have a resultant which is somewhere between the two. This resultant then becomes the new flight path with the model at an angle to it as shown. It is assumed that some force is now counteracting the torque.



With the fuselage no longer in line with the flight path, we present an altogether new face to the airflow. If we glance along this new flow we will see a compressed side view of the model. Let us take several designs from this view and find out how they will react under the same conditions.



CASE #1:- Using a flat wing. The wing halves balance each other. The rudder has a slight counteracting arm to the horizontal C.G. line but its effect is more than balanced by the landing gear. So we can expect the model to keep on rotating under the torque force.

CASE #2:- Using a wing with "V" dihedral. The wing has a counteracting force in form of changed angle of attack on the wing halves. The inside wing has a positive angle and the outside has a negative angle of attack; just what we needed for counter torque.

CASE #3:- A low wing with "V" dihedral. The effect is similar to #2 except that the lift forces are closer to the C.G., hence shorter moment arms, and the fuselage is blanketing and spoiling a portion of the outside wing and thereby putting greater load on the inside wing.

CASE #4:- A reversed dihedral. Works hand in hand with torque until rotation reaches 180° and then the dihedral assumes the "V" effect.

CASE #5:- Gull Shape dihedral. Shows how inefficient the gull shape is at large drift angles. Note how the outside tip has a tendency to blanket the inside angled portion of the wing. This shape should be avoided on high powered models unless exact drift angle can be calculated, and correct gull shape used.

CASE #6:- The Tip dihedral. This is used in many cases. Its effect comes from the long moment arm. Its danger is in the excessive upturn which might stall at large drift angles, thereby hastening the spin.

CASE #7:- High rudder to provide a long arm above the horizontal C.G. Its effect is small since the small chord might not provide the force expected, and thereby offsetting its purpose.

CASE #8:- A low rudder. It will help to rotate the model. Dihedral must be increased. Wheel pants have the same effect.

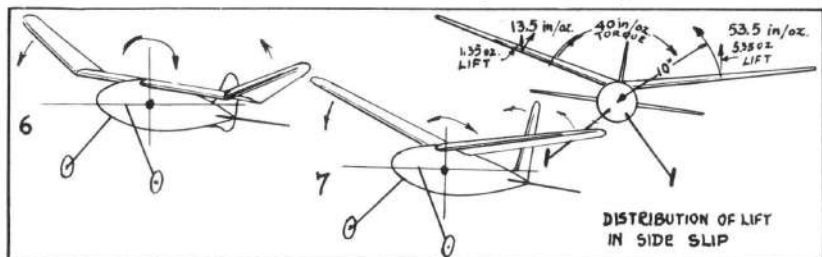
CASE #9:- Wing set on center fin. Small effect because of its short distance from C.G. Its use will call for a larger rear rudder. Might be of help on streamlined models where the fuselage has low drag and so making regular rudder too effective.

CASE #10:- Elliptical wing slightly parasol and divided rudders. Advantages of tip and "V" dihedral, plus no sharp dihedral breaks. Divided rudders keep the rear portion of the model neutral so that same adjustments will apply to power and glide conditions.

Of all the cases presented the "V" and Elliptical hold best promises. If you plan to use others, be sure to realize their limitations and make up the shortcomings. Also when flying these designs be sure to watch out for the tendencies mentioned

The next step is to determine just at what drift angle the wing will stop rotating and torque counteracted. The simplest answer is: When the wing reaches a point at which the drift angle will provide an angle of attack for the wing at which it can take care of the torque. Using the "V" dihedral wing for an example, the following calculation can be made:

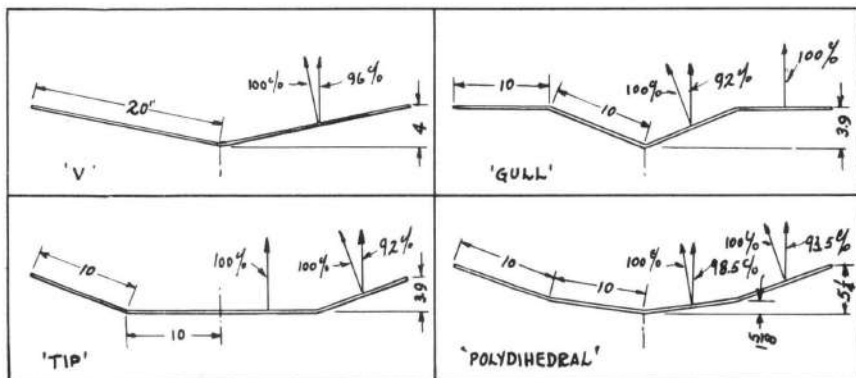
Referring back to our longitudinal stability model, we found that the 200 sq.in. wing had to carry a load of 62 ozs. The span of the wing is 40" and the dihedral is 4" under each tip, or 12° . The torque of a tightly wound motor suitable for an 8 oz. model is roughly 40 in./ozs. Shown on the diagram, this torque is distributed on the two halves of the wing at the 10" points where the lift of each half is centered. Note that we have upward and downward forces of 2 ozs. To counteract this torque we must decrease the lift of the outside wing to 1.35 oz. and increase the lift of the inside wing to 5.35 ozs. The ratio of the difference is 1 to 4. We must now find the drift angle at which the lift coefficients of the two halves will be in such a ratio. How to find these angles and more information on dihedral, we refer you to the following article by Albon Cowles.



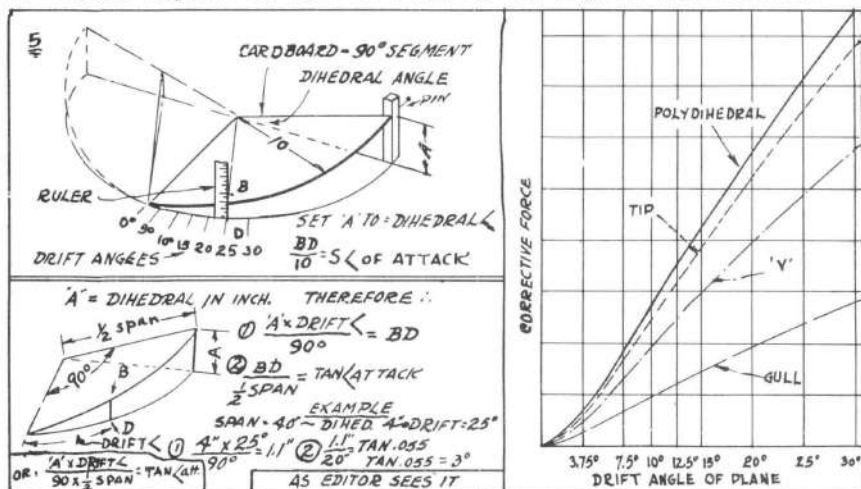
ACTION OF DIHEDRAL IN SIDE DRIFTS

by Albon Cowles

Diagrams from 1 to 4 show front views of dihedral shapes used in model designing. The various dihedrals were calculated so that the lift is equal for all cases. Using a lift of a flat wing as 100% efficient, the loss of lift because of dihedral triangulation is 4%; or we may term the dihedral 96% efficient. As explained in the 1937



YEAR BOOK, the torque of the motor produces a side slip to provide counter-torque force. The effect of such a side slip on the different dihedrals can be calculated by finding out the new angle of attack produced by the new airflow at an angle across the wing. The method used to determine the new angle of attack is shown on Diagram 5. The 10" radius segment is used to simplify the angular calculations.



Using the "V" dihedral for example, the calculations are made as follows: For 4" tip dihedral on a 40" span wing, the point "A" is two inches above the base on a 10" radius. Knowing the drift angle, the new angle of attack can easily be found by finding the distance B-D and solving the Sine formula of:

$$\text{Sine } C = \frac{BD}{10} = \text{Angle of attack}$$

Example: If drift angle is 25°, distance BD is 9/16" or .5625. Therefore, $\text{Sine } C = \frac{.5625}{10} = .05625$. Our trig tables show that the angle for Sine .05625 is 3° plus. We now have a wing whose inside half has an angle of attack of 3°, and whose outside wing half has -3°, or an angular difference of 6° in angle of attack.

Using a Clark Y airfoil we can make a complete table of Angles of Attack as developed by the different drift angles. All we need to know is the BD distance in decimals; move the decimal point to the left by one, and then find the Sine angle of this number under the Sine Table.

Example: Clark Y, Span 40", 'V' Shape, 4" under each tip. A: Inside wing. B: outside wing.

Drift Angle	Sine	Angle of Attack "A"	Angle of Attack "B"	Lift Coefficients "A"	Lift Coefficients "B"
5°	.015	1°	-1°	.45	-.35
10°	.0218	1 1/3°	-1 1/3°	.5	.3
15°	.0281	1 2/3°	-1 2/3°	.53	.27
20°	.0437	2 1/2°	-2 1/2°	.6	.2
25°	.056	3°	-3°	.63	.17
30°	.0687	4°	-4°	.7	.1

The method used to find the angle of attack of other dihedral shapes is a modification of the above system. Of course the different dihedral dimensions will change the Sine readings as will the different shapes. The Gull shape will use 3.9" since its maximum dihedral is at 10" point. This is also true for the tip dihedral. We will have to have a double table for the Polydihedral; one for each section.

When using the results thus obtained to find the resultant counter-torque force remember to apply this force at the correct spot. The force would be placed at the half-way mark for the "V". While GULL only gets it at $\frac{1}{4}$ point of the wing half, and the tip design gets it way out at the $\frac{3}{4}$ portion. The polydihedral will need two moment arms, one for each angled section.

Diagram 6 is a comparison graph of the different dihedrals set at various drift angles. The graph was calculated as on the "V" dihedral example for all the shapes given, and the forces applied at the correct spot as mentioned in the above paragraph. The individual calculation tables were too lengthy to include in this article. However, the graph is a true indication of the counter-torque force relation of the dihedrals when all the wings have same characteristics while flying at same angle of attack and at zero drift angle. Of course any deviation from the forms given would result in different readings. Increasing the tip dihedral of the GULL would undoubtedly make a better showing. But since it is the purpose of this article to show the extremes, modifications and special designs will have to be calculated by the reader.

The graph was also plotted without reference to the parasol effect or the lengthening of the moment arm due to increased distance between the center of lift and the C.G. An increase in parasol would be most beneficial to the GULL, and slightly to the POLYDIHEDRAL.

The results shown are purely mathematical, and coefficients used are as listed for regular airplane use. No correction was applied to possible interference where the change of dihedral is affected. Results show the Polydihedral to be best of the series, and this would let us to believe that an elliptical shape, which is similar but without dihedral breaks would be best.

SPIRAL STABILITY (Continued)

To find the lift coefficient difference of the two halves of 1 to 4 for our test model wing, we must make a table similar to Cowles'. Except that we will use Gottingen 497 instead of Clark Y. We can use his Drift Angle, Sine and Angle of Attack readings since they are applicable to our 200 sq.in. wing which also has a 40" Span and a 4" tip dihedral. We will add to his table the drag coefficients and the lift ratios of the two halves to enable us to make quick comparison at various drift angles.

Drift Angle	Sine Value	Angle of Attack		"A" Coefs.		"B" Coefs.		Lift Ratio "B" to "A"
		"A"	"B"	Lift	Drag	Lift	Drag	
5°	.015	1°	-1°	.6	.034	.5	.027	5 to 6
10°	.022	1 1/3°	-1 1/3°	.67	.040	.45	.022	4.5 to 6.7
15°	.028	1 2/3°	-1 2/3°	.69	.043	.43	.021	4.3 to 6.9
20°	.043	2 2/3°	-2 2/3°	.75	.050	.35	.020	3.5 to 7.5
25°	.056	3°	-3°	.80	.055	.32	.018	3.2 to 8
30°	.068	4°	-4°	.86	.060	.27	.017	2.7 to 8.6

The above table shows that at a drift angle of 30° we approach our required ratio of outside and inside wing lift difference of 1 to 4. The calculations were made with the assumption that the angle of attack was 0° when the fuselage is parallel with the airflow. The lift coefficients for 4° and -4° angle of attack differences for the

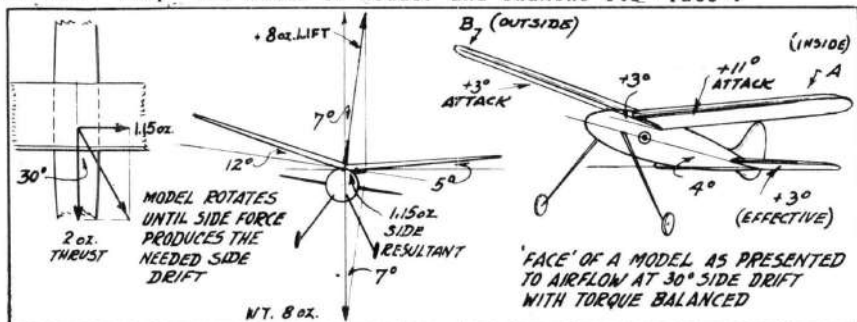
two halves might prove to be two small in value to produce the required counter torque force. Consequently the angle of attack of the entire wing will have to be increased until the counter force is large enough. On our model the angle of attack had to be 7° to satisfy the wing and stabilizer balance. This increase would give us 11° for the inside wing and 3° for the outside wing. Note that we keep the required 8° difference for the counter torque force. The torque force is now balanced because we have reached the setting at which the entire wing lifts 8 ozs. How about our longitudinal stability? Using our Longitudinal Stability calculations, we have:

Results for individual wing halves, (A) $100 \text{ sq.in.} \times 1.25 (11^\circ) = 375 \text{ Units}$
 model set at 7° Angle of Attack: (B) $100 \text{ sq.in.} \times .75 (3^\circ) = 225 \text{ Units}$
A total of 600 Units

Our stabilizer's UNITS totaled to 648 so that the the angle of attack will be decreased slightly until the longitudinal balance is reached. However, the change will be small since the stabilizer is now less efficient because the rudder blankets considerable area at the drift angle of 30° . The slight decrease in angle of attack should not change the counter-torque force because the model will automatically speed up at lower angles because of reduction in drag. So that we can now assume that we have the model under control in all respects

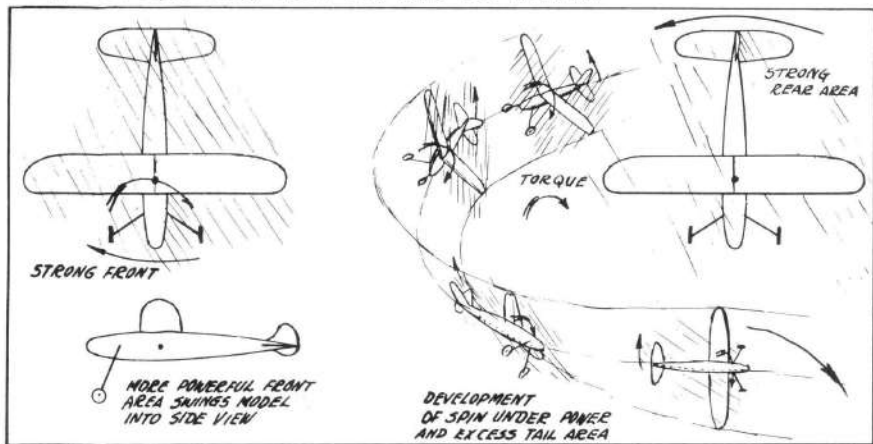
A glance at the differences in the drag of the wing halves should explain why the model's natural circle is with the torque. The position of the model with respect to the horizon will depend on the thrust power. (The difference between thrust power and torque is that thrust power is the final pulling force of the propeller; while torque is the power required to run the prop. The torque is high when prop is inefficient and low when it is working under ideal conditions. More about this later.)

The next step is to calculate just what sort of a "face" the model presents to the airflow. The approximate "face" can be calculated as follows: Let's us assume that the maximum thrust for our model is 2 ozs. Placing this force in our 30° drift diagram we obtain 1.15 oz. side force. (It is simpler to work backwards. Too many unknowns if we start from scratch.) Using a scaled diagram, we find that the wing has rotated 7° to reach the counter torque point. We can now "stop" the model in midair and examine its "face".



The sketch shows us that the inside wing has almost reached the horizontal position, the difference being 5° . (12° dihedral and 7° rotation.) The angle of the attack on the inside wing is 11° which determines the angle of the model as presented by the fuselage lines. This then is the position of a stable model when torque forces the wing to seek the counteracting force. It is of course assumed that forces are balanced on each side of the C.G. and that the higher drag of the inside wing is causing the model to circle with the torque. But what happens when other or counter forces are introduced?

FIRST CASE: Let us assume that the area behind the C.G. is too small to balance the area in the front. In practice, rudder area too small. Referring to the plan view of a model in a 30° drift angle we can see that the more powerful front force will try to swing the model into still greater angle. If the drag increase of the inside wing is not sufficient to counter-act the front force, the drift angle will continue until fuselage will be presenting almost the full length view. Consequently the overall drag will increase and lift efficiency will drop until the model just flounders. A good indication when a model has too small rudder is tailwags back and forth as it approaches a stall while under low power. Under high power, the model just makes a right or left wing over, and dive for ground.



SPINNING WITH TORQUE TURN

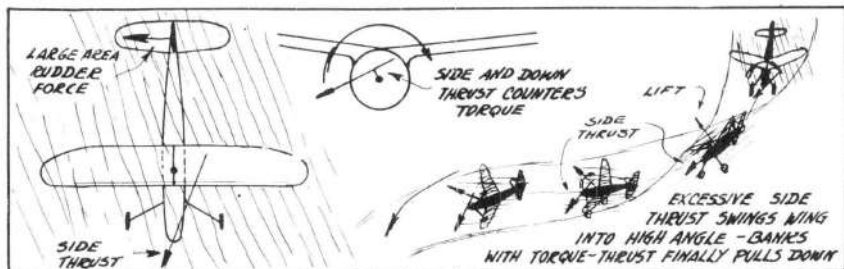
SECOND CASE: The assumption now is that the rear portion has too large an area. In practice, rudder too large. Referring again to the plan view of a model in a drift angle we see that the large rudder tries to force the fuselage into the airflow, or decrease the drift angle. We have just calculated that our design has rotated 7° to achieve the 30° drift angle. But if the rudder keeps on forcing the model to face the airflow we can realize that the wing never reaches the 30° drift angle, and if this is the angle needed for counter torque force, the torque keeps on rotating the wing. If we did not have gravity, the result would be a horizontal spiral flight with wing rotating. But with gravity always waiting to pounce on the unwary, we have the following results when the rotating wing reaches a vertical position. The lift is now horizontal, which accounts for tight circles. And the large rudder act like a stabilizer forcing the nose into a dive. The outcome is the familiar fast twist commonly known as a "spin". Cure: Reduce the rudder area until the wing can assume the required drift angle to counter-act the torque. Or increase the dihedral so that the required force will be obtained at lower drift angles at which the rudder does not assume dominant position.

CIRCLING AGAINST TORQUE

During the last four years it was found that a model can be more easily adjusted if it is flown against the torque. A model which would normally spin very easily when circling with the torque, could be made to perform good in 'against torque' adjustments. Also that the best adjustments were made by offsetting the thrust line. Adjusting with the rudder alone usually forced the model into a spin after the power used up.

Circling with the torque proved so successful because the side torque minimized the domination of the extra large rudder, which caused the spin in with the torque turn. Examining the diagram you will see how side thrust balances the large rudder effect. If they balance, the wing reaches its drift angle and torque control is maintained. Normally, our excessive power assumes domination and the model circles to the right. The drift angle remains as before as the wing still has to control the torque. The side thrust does counteract the torque in a mild way as shown by the force diagram.

This then is the explanation why we are able to use large rudders when we adjust models to fly against the torque. If we adjust by rudder alone, we lessen its effective side area. And by thrust line we provide a counter balance. The scheme of the arrangements works out well as power becomes exhausted: The drift angle decreases and with it the danger of large rudders. A slight right rudder is usually used in combination with side thrust to continue the circle after the power is out.



SPINNING WHILE CIRCLING AGAINST TORQUE

At first glance, it would seem impossible to spin circling with the torque. Especially since our minds are so fixed with the idea that the inside wing is always low for torque control. It is hard to reason how a model would rotate in direction favoring the torque. However, the models spin so there must be a reason. Our reason does not deal with gyroscopic forces which also seem to be more effective while circling against the torque. A detailed article by Mr. Cameron will cover that viewpoint.

Spins while circling against the torque usually occur while we still have high or excessive power. Referring to the diagram we can see that if the thrust force exceeds the rudder balance, the model will swing into still greater drift angle. Consequently the wing will have excessive torque control and it will begin to rotate in torque direction. If high power still persists, the rotation will continue until the wing is banking for the right turn. As soon as we begin to steepen the bank the lift is angled and higher speed required for level flight. But at the same time the side thrust is now no longer sideways but downward. With lift lost through steep banking, and side thrust now developing a down force, the result is our familiar spin.

Cure for spinning against the torque is to reduce the side thrust. Increasing the rudder area would help, but it would be a combination of two wrongs making one right with results that as soon as one becomes weak the other dominates. We still come back to our old standby; too large rudder, because if the rudder was not too large in the first place we would not have to use such excessive side thrust which would upset the balance. A larger dihedral would also help by keeping the drift angle small and so lessening the rudder and side thrust balance.

SPIRAL STABILITY IN A GLIDE

We do not have much trouble with spiral stability in a glide as we do while under power. This is mostly due to the fact that most of the present models use considerable dihedral which brings the model back into flight line if an upsetting force is applied. The trouble will usually be found on soaring gliders or models which have small dihedral and large rudder. The action is as follows:

An upsetting force causes the model to rotate and so bring in our famous side force. The action is identical as described under "spinning with torque" section, except that our "torque" force is now the weight or inertia of the rotating wing and model which has to be brought back to a level position. To do this we must get our drift angle, and so increase the angle of attack on the inside wing. With introduction of side drift, we cannot keep the rudder out of it. If the rudder is of correct size, we will have no trouble. But if it is too large, the wing will never reach the required drift angle and the initial upsetting force will continue to rotate the model until the model tightens the bank. With steep bank the lift is lost since we have no excess thrust to speed up the model. With lift gone, and the model in an almost vertical bank, the rudder does its dirty work and dives the model into the ground.

The above action can be right or left, depending on the upsetting force. The danger of sharp turned rudders will become apparent mostly in a glide, especially if the rudder borders near too large area proportions. This action can be best brought home by quoting from actual flight tests made by Mr. Weick as reported in N.A.C.A. Report No. 494

REPORT No. 494

A FLIGHT INVESTIGATION OF THE LATERAL CONTROL CHARACTERISTICS OF SHORT WIDEAILERONS AND VARIOUS SPOILERS WITH DIFFERENT AMOUNTS OF WING DIHEDRAL

By FRED E. WEICK, HARTLEY A. SOULE, and MELVIN N. GOUGH

EFFECT OF DIHEDRAL

In order to make an appraisal of the effect of dihedral on the characteristics of the various lateral control systems, it was first necessary to determine the effect of dihedral on the stability characteristics of the airplane. It was known that the dihedral principally affected the rolling characteristics of the airplane under conditions of sideslip. It was not expected that the longitudinal stability would be greatly affected by the dihedral change and the flight tests showed this to be true. The airplane was longitudinally stable with all the dihedral angles for the conditions tested and, as far as the pilots could determine, the characteristics were the same in all cases. An attempt to separate the directional stability characteristics from the more general lateral stability characteristics was successful only at 0° dihedral, where the rolling due to sideslip was small. There the tests indicated that the airplane had a fair degree of directional stability.

With 0° dihedral the airplane was definitely unstable laterally. When deliberately caused to sideslip in either direction, it would turn in the direction of the initial slip and spiral indefinitely whether the controls were freed or returned to neutral. By an increase of the dihedral to 3°, the stability characteristics were

what improved. In this condition, the airplane was unstable only with the controls freed. With the controls neutralized the airplane would recover to straight flight after a few oscillations. With 6° dihedral the airplane was stable both with free controls and with the controls returned to neutral.

The airplane exhibited instability of a different type with 9° dihedral and controls free. When sideslip was started to the right, for example, and the controls freed, the airplane would turn directly to the left away from the initial sideslip (whereas with 0° dihedral, it had turned into the sideslip) and would commence a left nose-down spiral accompanied by a rapidly increasing air speed. When the controls were returned to neutral during a sideslip, the airplane returned to straight flight with no apparent oscillation.

In connection with these tests it was noted that the rudder, when freed, had a greater tendency to deflect to the right than to the left, thus introducing some asymmetry in the motion following a right or left sideslip. The reason for this has not been ascertained. The observations on the lateral stability previously given represent average conditions for the two directions of sideslip. It was also observed that in a sideslip the wide-chord aileron of the forward wing would

trail up when the controls were released and stay there through all the ensuing motion until straight flight, if the airplane were stable, was regained. If the airplane was unstable, the ailerons remained in the initial position taken, regardless of the form of the instability.

With the wing set at 0° dihedral the rudder gave almost independent directional control, the banking due to the yaw produced being very slight when the ailerons were held in neutral. Turns could be made without the ailerons but they were characterized by skidding during entry and sideslipping during recovery, the amount depending on the abruptness with which the rudder was used. As noted previously, if the ailerons were freed during rudder movements, the trailing of the outer ailerons might result in the wing digging in and banking in the wrong direction for the turn; a deliberate sideslipping therefore required careful handling of the ailerons. The increased banking effect obtained with 3° dihedral eliminated all tendency of the forward wing to dig in and made sideslips easier to perform. The effect was noticeable also when rudder turns were made. Tight, or steeply banked, rudder turns, however, were difficult to enter as the airplane would nose down during the time taken to roll to the desired angle of bank. If an attempt was then made to bring up the nose with the rudder, the airplane would start sideslipping and would roll out of the bank. The airplane always banked in the direction of the turn set up by the rudder, whether the ailerons were held in neutral or freed. With 6° dihedral, the rudder had a powerful banking effect and it was difficult, with full aileron deflection, to hold the wings level for any but small amounts of sideslip. The roll that could be generated by the rudder at 9° dihedral was so great that the rudder had to be handled with discretion and sideslipping was practically impossible. With 6° and 9° dihedral, the airplane showed a progressively greater tendency than at 3° to nose down and roll out of rudder turns.

Dihedral.—Increasing the dihedral, as expected, increased the roll due to sideslip; the results obtained with the increased dihedral, in general, showed that this was the only variable of importance. Lateral control systems with negative yawing moments are adversely affected by increasing the dihedral. In the present tests with 9° dihedral it has been seen that the rolling moment resulting from the yaw was sufficient to counteract entirely that of the wide-chord ailerons. Even though the rolling moment of the ailerons was not entirely counterbalanced at 6° and 3° dihedral, increased deflections and consequently increased forces were required for normal maneuvering. With the spoilers for which the yawing moment was positive, the dihedral had considerable effect in reducing the apparent lag. At 9° dihedral the rolling set up through action of the positive yawing moment was apparently sufficient to cover up the lag of the spoilers. This statement seems to be a contradiction of the fact that with the saw-toothed spoiler, lag was recorded with instruments at 9° dihedral. A possible explanation is that the lag in the rolling action may depend directly on the drag caused by the spoiler—and the plain spoiler had considerably more drag than the saw-tooth spoiler. Thus, the saw-tooth spoiler may cause considerably less yawing than the plain spoiler and have greater

lag in its rolling action, so that at 9° dihedral, the saw-tooth spoiler could still have shown some apparent lag, whereas the plain spoilers showed none. The rolling due to the rudder was so greatly increased by the dihedral that at 9° dihedral steady stalled flight was more nearly maintained with use of the rudder than with any of the lateral controls.

The fact that the airplane exhibited spiral instability with 0° dihedral showed that the fin area was too large for the dihedral. As the ratio of dihedral to fin area was increased, the airplane became laterally stable. The optimum dihedral angle tested was 6° . With 9° , the dihedral was too large for the fin area (rudder free) and instability was again present. In this condition the airplane turned out of the sideslip, maintaining its initial yaw, and spiraled with increasing speed in the opposite direction.

The ability to sideslip is important in a conventional airplane with a small range of gliding angles and a poor field of view ahead and down, as it permits the pilot to obtain a better view of the landing field before the start of or during the landing glide. Dihedral decreases the ability to sideslip. The rolling due to yaw, with dihedral angles above 6° , was sufficient to preclude the practical use of sideslipping as a maneuver. Evidently, the ability to sideslip and maintenance of lateral stability involve opposite considerations concerning the dihedral and some compromise must be made regarding them. As lateral stability is probably more important than the ability to sideslip, the optimum dihedral angle for this airplane with the special wing, considering both features, is probably of the order of 5° —an angle that will give a fair amount of lateral stability and still will permit a limited amount of deliberate sideslipping.

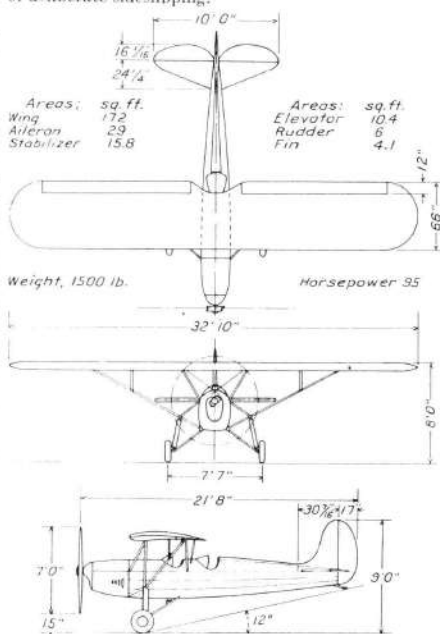


FIGURE 2.—Three-view drawing of Fairchild 22 airplane.

CALCULATING THE DIHEDRAL ANGLE AND RUDDER AREA

Considering how important dihedral and rudder area are, one would imagine that our libraries would be chockfull of formulas which would give us the correct answer to all our questions. However, the truth of the matter is that full size craft do not have to be so inherently stable as models. Besides they do not have to contend with such out of proportion torque as we do. They just allow a few degrees for dihedral, and calculate the rudder partly from the preceding models or by formulas which have a great many unknowns. Most of these formulas depend on accurate data. Since we do not have that, we cannot use full size formulas as they are.

DIHEDRAL

The dihedral angle can be best decided upon from past experience with models having similar prop and power; especially since a large dihedral is mostly used to counteract the torque. Or you can check on other models which proved to be stable. An $1\frac{1}{2}$ " for every foot of span under each tip seems to work well for fairly high power models around the 200 sq.in. class. Gas jobs, on the other hand will get away with 1" per foot on large spans of over 3 feet. Small high powered gas jobs will need more, almost as much as high powered rubber models. Just remember that the moment arm of the counter-acting force has a great deal to do with torque control. If you think that your model does not have enough dihedral, do not hesitate to add more if you intend to use high power. Of course, there is a loss of lift due to wing triangulation, but the first requirement is stability.

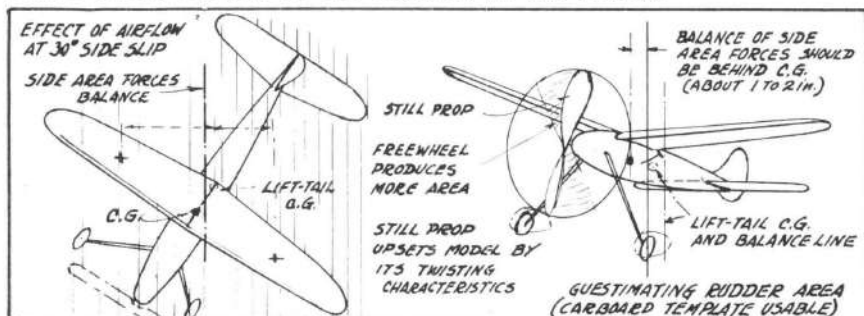
The shape of the dihedral has been well covered before. A word of caution on tip dihedral. We realize at what high drift angles the wing works. Now place your tip into this airflow and see how it would react. If the reaction is not too high angled, and tip drag normal you can safely use it. But if there is a danger of having the tip stall, you had better help along with polydihedral. The elliptical would seem best from all viewpoints. Besides introducing long moment arm, the shape of the tip also helps to have a more gradual interflowing of high and low pressure, and so reduce the tip turbulences which cause considerable drag.

RUDDER

In the past Year Books we recommended the side view pattern of the model to obtain approximate rudder area. It is a fair method if the user knows its limitations. Just what affects the rudder area? First we have to balance the fuselage area on each side of the C.G. Normal rectangular cross section fuselages have large area in the front, and a bit of rudder is needed to affect the balance. A streamlined model does not have very strong resistance factors while at an angle and its Center of Pressures are almost at the usual C.G. So we can treat streamlined models as sticks. Next in line is the wing. A wing in a drift angle usually has excess drag on the inside wing with the result that it tries to pull the fuselage into the drift angle. Since this is the exact action of a large rudder we would forget the wing in rudder calculation if it were not for the fact that the drag resultant might be weak if lifting tail is used and so brining the C.G. far back, and also when drift angle is large. So we add another trifle of area to rudder. The landing gear should be used completely, as the area presented is directly apposing the rudder. It is in this side drift angle that we note how much more drag a wheel has with streamlined than without them. From this viewpoint a thick wheel would seem best. Or we can attach the streamlined pants in

castor fashion so that they will adjust themselves to the airflow. The final object is the prop. The prop is one member which usually eats up most of our rudder area.

While under power and at drift angle the prop influences the rudder by its slip stream and its thrust adjustments. The slipstream is probably almost angled by the airflow by the time it reaches the rudder, so its effect will be slight. It would call for a bit of extra rudder area to keep the balance between the rudder and the wing. The side thrust is altogether another problem. It needs considerable area to keep it balanced as it was shown in preceding sections. In a glide the prop comes into side area picture whenever the model is angled into a drift. The difference of prop reaction under power and in glide is that under power the prop blades actually have higher airstream than the rest of the model, while in a glide they have the same, and thereby contributing to the general drag. Effect of a prop in a glide during a side drift is to counteract the rudder area. It is evident that we must have rudder area to take care of the idling prop or the front portion of the model will dominate. A freewheeling prop needs more rudder area than one fixed. A fixed prop presents a definite area, while a freewheeling prop presents a partially completed circle because of the rotation of the blades.



After reading these paragraphs you will very likely still be in dark about how to calculate rudder area. However, do not blame your ignorance as no one has the exact method. But you should have an idea just what influences it. If you can work out a formula from so many unknown variables, you may sure that something is wrong somewhere. Our best method in finding the correct rudder area is to keep a record of the models and their behavior. After a while, the guestimating of rudder area will be a second nature, we hope.

TEMPORARY ADJUSTMENTS

After you have built a model and found it unstable check over all the points brought up, and if you think that you have reached the trouble, do something about! You might be wrong but at least you will begin to investigate systematically. What good are the builders who have an unstable model, crack it up, repair it without a thought of what is wrong, and then go out again for another crack-up. They are a menace to humanity and a black mark against the sport.

If we were to take the present trend in design most trouble will come from using too large rudders. This fact will actually stare us in the face, yet we will do nothing about it. We would rather do anything else but change the rudder. Ohno, not the rudder! Undoubtedly this is because we spent so many hours drawing out the beautiful outline! And it would hurt our artistic taste if we were to cut off the top portion. But science recognizes no arts which would keep it from

the truth. So use all your will power, and cut that rudder down if you think that it is the cause of all the troubles. If you cannot bear to do it have your friends do it for you, but do it!

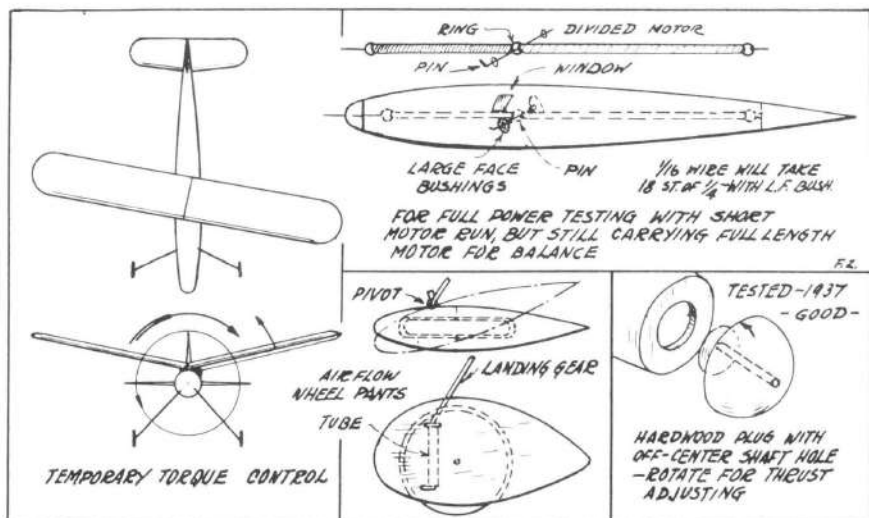
Another way of temporarily adjusting for spiral instability is to cock the wing in relation to the fuselage. In front view this will give us extra incidence to take care of the torque without bringing the rudder into play. Warping one side also helps if power is not too large. However, these adjustments usually produce a poor glide because they naturally bank the model to even up the lift of the wing. In banking they usually produce a side flow which attempts to spin the model to the right after the power is out.

SUMMARY OF THE STABILITY CHAPTER

It is hoped that the discription of the different stability problems will give you a better insight of what goes on. If you can understand clearly the foregoing pages, the explanations should uncover many mysteries. One of them being why streamlined models did not come up to expectations. A streamline fuselage is a very lively thing and one cannot put a finger on its center of pressure for calculations. Consequently, most streamlined models had stability problems which prevented them to show up against 'boxes' which in their very sluggishness achieved a sort of balance. However, a picture of the airflow about the model should prove that only a streamlined model can hope to achieve the acme of perfection. Let's spend the next few years working out the stability problems of streamlined models.

TESTING PROCEDURE

One of the most exasperating experiences is to bring, what we thought a well adjusted model to a contest only to be bitterly disappointed when we give it the "works", or to give the model full power wind-up and then have it fly beyond recovery. A cure for these heart breaks is to equip your model with a pin-and-tube combination about 10" from the nose. All you do is to divide the motor in the fuselage and push a pin through the ring. Now only the front motor is used which can be given the works without danger of losing the model.





GAS model fans who may have looked thoughtfully at the shattered remains of what a few minutes before was a beautiful creation representing possibly months of work, and wondered why the crash occurred, will do well to read carefully the feature article in this edition of M.A.L.C. News. Jim Cameron, one of the many gas model experts out Vancouver way, has prepared an article on this subject based on theory and indicative of holding true in practice. We recommend that what Jim has to say be studied carefully and his advice put to use.

THE GYROSCOPE AND THE GAS MODEL

By D. J. Cameron

Foreword: Of the fifty thousand or so gas models in the United States and Canada, probably forty thousand will crash this year. If the fellows applied the principles of correction, and I believe this article will assist toward that end, a total of about \$80,000 would be saved in crack-up repairs and far fewer builders would get discouraged.

I have tried to write the article so that everyone can understand. The development of the equation may be beyond many, but the final equation (No. 4) can be understood and used by all. The equation is necessary to prove to a great many people that what has gone before is correct. It may seem like an odd mixture of simple and technical terms, but I

don't think it could be presented in any other manner.

It is desired to acknowledge the help given me by my friends, particularly Victor Hill, who aided in bringing the equation to a simple form and made many helpful suggestions.

YOU Gas Model builders have all seen a gas model crash, and nearly all of you have crashed your own ship at least once. It wasn't due to bad workmanship or design that your model crashed; it was due, as is the case in nine out of ten crashes, to the **GYROSCOPIC EFFECT** of the Propeller of your machine. You may have noticed that models using motors that turn in a counter-clockwise direction (Browns and Cyclones) are apt to crash during right-hand turns. I crashed my first machine three times in right-hand turns, and I have seen more than 50 other machines crash in similar turns, but I have never seen a good model crash in a left turn. Rod Doyle, writing in Zaic's Year Book, made a similar observation; however, he made no attempt to explain the question.

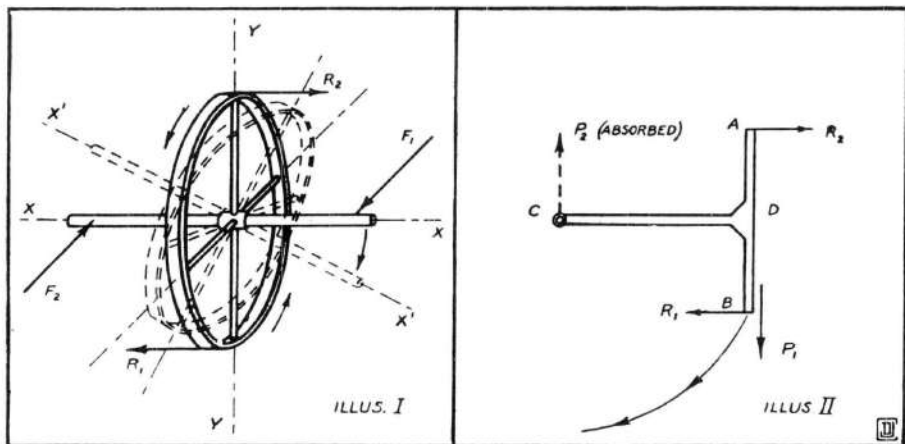
Most of us correct for the torque of the propeller. It is this correction that causes the right-hand spiral dives that result in a crash. You can prevent your model from crashing by remembering just one simple rule. **ADJUST YOUR MODEL TO FLY STRAIGHT OR TO TURN WITH TORQUE.**

In the following paragraphs I will attempt to explain as clearly and simply

as possible the cause of most gas model crashes, and to formulate an equation by means of which you can calculate the upsetting forces developed by the propeller of your machine.

The propeller of a gas model seems insignificant when compared with the whole of the model. However, because of its extremely high speed of rotation (4,000-7,000 r.p.m.) the propeller has a rotational or gyroscopic inertia of considerable magnitude, a fact which we cannot afford to overlook. When the propeller is turned (as the machine turns) the forces produced by its gyroscopic inertia are sufficient to cause what is equivalent to a 2" shift in the Centre of Gravity of the model. I am sure you will agree that a 2" shift in the C. G. will cause even the best of designs to crash.

In order to understand clearly what takes place, it is necessary to know something about a gyroscope. It is a well-known fact in mechanics that a gyroscope when forced to turn, reacts at right angles to the turning forces. Illustration I shows a simple gyroscope rotating in a counter-clockwise direction. The initial turning forces are F_1 and F_2 , two equal and opposite forces. The resulting forces are R_1 and R_2 ; you will notice that R_1 and R_2 are in a plane at right angles to that of F_1 and F_2 . The result is that the gyroscope tips forward as shown by the dotted lines. If F_1 and F_2 were from the opposite direction, the gyroscope would tip back, not forward. To prove these facts to yourself, try twisting a spinning bicycle wheel and notice how pronounced



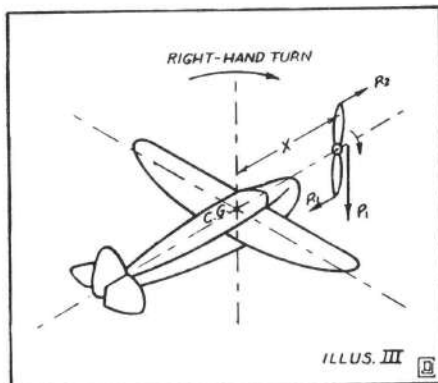
is the effect. We won't go any further into why the gyroscope reacts in this manner, as it is purely in the realm of physics, and can only be explained by terms and quantities with which you may not be familiar. Any good book on elementary mechanics will explain the phenomenon, if it can be called such, quite clearly.

Now consider R_1 and R_2 as though they were applied to the solid assembly in Illustration II. This whole assembly

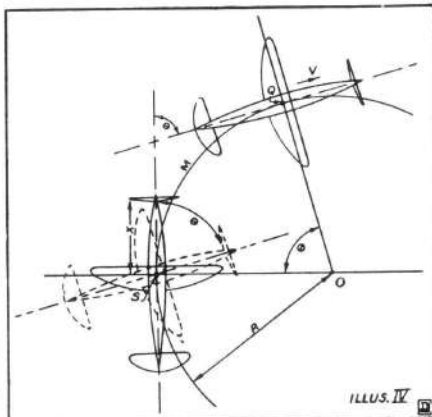
(think of it as a "T" square with a nail at the point C) is capable of rotating about the point C. When R_1 and R_2 are applied to this assembly it will move down and around. If you do not see just why it moves thus think only of the piece AB. AB would rotate in the direction shown if there was no joining piece CD, but as CD joins solidly to AB and can rotate about the point C, you can see why the whole assembly will rotate about C. The two forces P_1 and P_2 are the resultants of

R_1 and R_2 , P having no visible effect at the fixed point C.

We can now apply this information to our model. Consider Illustrations I and II applied directly to the model in Illustration III. Let gyroscope in Illustration I be the propeller of the model and axis XX the fuselage; then we can consider the member AB in Illustration II to be the propeller, member CD the fuselage and the point C, the C. G. of the model. The initial turning moment of F_1 and F_2 (not



ILLUS. III



ILLUS. IV

shown for reasons of clarity) is the same as that exerted by the rudder during a right-hand turn. R_1 and R_2 are exactly the same. P_1 is also the same. P_2 acting at the C. G. has no moment arm and is not to be taken into consideration. Now the force P_1 acting at the propeller, times the moment arm X (distance to C. G. of airplane) is the upsetting moment during a right-hand turn and the direct cause of our trouble. If you understand all this, you will see that in a left-hand turn, P_1 acts upward; conversely, in a dive it acts to the right; in a climb it acts to the left.

The magnitude of the gyroscopic effect depends on a number of things: the radius of turn and speed of the model determining the Angular Velocity of Precession; the weight, diameter and r.p.m. of the propeller, and the length of the moment arm X . The value of the force P_1 can be found by an equation developed for this purpose.

The following is the development of the equation to find the value of P_1 . You can substitute your own values and obtain the desired result even though you may not understand the derivation. Incidentally, this equation may be applied to full scale aircraft as well as to our gas models. The following symbols are used to represent the factors involved:

P_1 = The gyroscopic force in lbs.

X = Distance of C. G. of propeller to C. G. of model.

W = Weight of Propeller (lbs.)

K = Radius of gyration of the propeller in feet.

g = Acceleration due to Gravity = 32.17 ft. per sec.

r = Radius of Propeller (ft.)

R = Radius of model's turn.

N = R.P.M. of propeller.

V = Speed of Flight (M.P.H.)

The average value of K in our case is very nearly $3r$ ft., so that we may say $K^2 = .09r^2$. Due to the difficulty of obtaining this value experimentally, you will have to take my word for it. The mathematical derivation is too lengthy for presentation here.

Illustration IV shows a model making a right-hand turn. θ representing the angle traversed by the model in one second. The propeller has turned through this same angle θ as shown by dotted lines.

The Arc SMQ = Distance traversed in one sec. = V

$$= \frac{5280}{3600} V = 1.466V \text{ ft.} \quad (1)$$

$$\text{Angle } \theta \text{ (radians)} = \frac{SMQ}{R} = \frac{1.466}{R} \frac{V}{R}$$

θ then, is the Angular Velocity of Precession of the Airplane about the point O , and also of the Propeller about the points S .

Turning Moment of Rudder about Vertical Axis (through S) = Pitching Moment about Transverse Axis (also through S) = Load at Centre of Prop \times Distance of Centre of Prop. from S = $P_1 X$.

We can say therefore, that $P_1 X$ = Reluctance of Prop. to swing about S = Moment of Inertia of Prop. about its centre \times Angular Velocity of Prop. about crankshaft \times Angular Velocity of Centre Line of Machine.

$$\frac{W}{g} P_1 X = -K^2 W W_0 \quad (2)$$

where W_0 = Angular Velocity of Propeller

$$= \frac{2\pi N}{60} = \frac{2\pi N}{30} \text{ radians per second.}$$

W_0 = Angular Velocity of Centre Line of Machine during turn

Velocity of Prop. C. G. about S

$$= \frac{X}{R} V$$

$$\text{Velocity of Prop. about } S = X\theta = X \frac{1.466}{R} \frac{V}{R}$$

$$\therefore W_0 = \frac{1.466}{R} \frac{V}{R} \text{ radians per second.}$$

$$\therefore P_1 X = -K \left(\frac{2\pi N}{30} \right) \left(\frac{1.466}{R} \frac{V}{R} \right) \quad (3)$$

$$\text{Since } K^2 = .09r^2 \quad (0.09) (1.466) (3.1416) \left(\frac{W N V r^2}{X R} \right)$$

$$P_1 = \frac{(32.17) (30)}{X R} \left(\frac{W N V r^2}{X R} \right) \quad (4)$$

This is the Equation in Usable Form. We will now apply the conditions that bring about a crash during a right-hand turn.

$W = 4$ ounces = 25 lbs. (Wt. of Prop.)

$N = 6000$ R.P.M. (Revolutions per minute of Prop.)

$V = 30$ M.P.H. (Speed of model)

$r = .583$ ft. (Radius of 14" propeller)

$X = 12$ = 1 foot

$R = 20$ ft. (Radius of turn)

$P_1 = (.000429) (.25) (6000) (30) (.3396)$

$$= 32799 \text{ lbs.} = 5.248 \text{ ounces}$$

Since P_1 is acting downward through the C. G. of the Propeller, with a force of 5.248 ounces, the nose of the model will drop, the speed of the model will increase, and the R.P.M. of the propeller will increase. As the R.P.M. of Prop. and the speed of the model increase, the value of the upsetting force increases. With a speed of 40 M.P.H. and an R.P.M. of 7,000 the value of P_1 is about 9 ounces, sufficient to move the C. G. forward 2". In other words, the Gyroscopic Force varies directly as the velocity of the aeroplane, the weight, radius and R.P.M. of the propeller, and inversely as the distance from the propeller to the C. G. of the 'plane and the Radius of turn. Now you can see why it is that so many models crash in right-hand turns. There is, of course, a limit to the right-hand turn that will cause a crash. A turn of radius greater than 100 ft. will not set up forces sufficient to cause a crash.

As we have already observed, a model flying in a left-hand circle flies well—it does not stall as might be expected even though the gyroscopic effect is acting upwards. The explanation is this: the righting effect of the stabilizer is sufficient to counteract the gyroscopic effect at positive angles of attack since the Centre of Pressure of the wing has moved forward. However, in the opposite case during a right-hand turn, when the angle of attack is negative and the Centre of Pressure has moved backward, the righting moment of the stabilizer is insufficient to counteract the downward acting gyroscopic force. Pitching Moment Curves bear out these statements. This question may have been in your mind; I hope the explanation is clear.

In conclusion I will say that by using this knowledge of the gyroscopic effect, an entirely new field of flight and flight adjustment is open to you. May good fortune attend you at future contests!

PROPELLER

The power and propeller question seemed to have been well taken care of in 1937. Most of us used large diameter propellers, and if they proved sluggish, we put on more power or cut down the diameter. This is the simplest method of achieving high power to weight ratio.

The propeller theory is undoubtedly known to all by now. The blades being nothing else but twisted wings. The lift resolves into a forward thrust, and the drag into torque. Treating the propeller like a wing we can understand that the lift, or thrust, must overcome the drag of the model. If the model has low drag, even a small thrust will move it. While a high drag model will need larger thrust forces. Referring these extremes against wing theory, we note that for a small thrust the propeller can be small or have low rotational speed. But to obtain large thrust force we must either increase the speed of a small propeller, or increase its size, or a combination of both.

TORQUE AND THRUST

The importance of reducing torque force cannot be overemphasized. We have seen what awkward positions our models have to assume to control this power. Most of the instability forces can be traced to it. If we knew how to achieve the best power, propeller and model combination, our troubles would be over. But these things are still in the experimental stage. So the next best thing is to review the factors which constitute the propeller forces.

If the propeller is too small, in size or rotational speed, for the model, the blades will assume high angle of attack. And we know how high the drag is at large angles, and how closely we are flirting with stall or no thrust. On a model this is evident by high speed prop whizz with very small forward motion. Cure; larger propeller, even if it means more power.

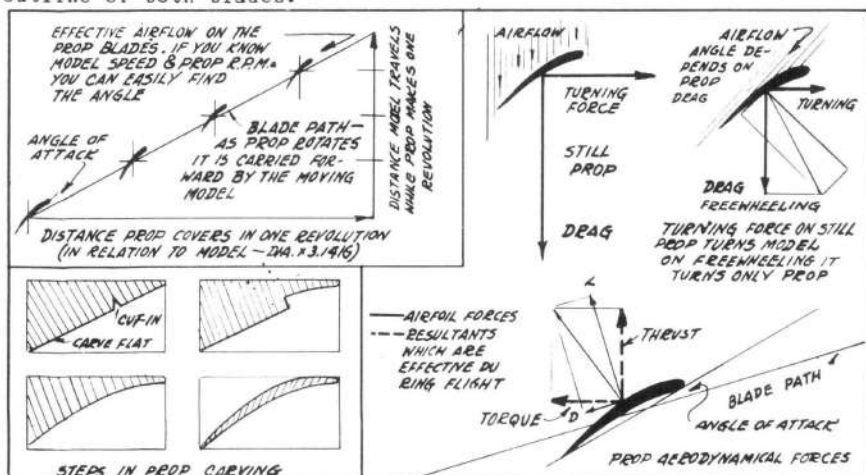
Then we have a high pitch propeller working on a sluggish model. Working out the propeller and model distance covered during the same period of time we find we have high angles at the point where we obtain the needed thrust. Cure: Lower pitch. Increase of power would be wasteful as we get very poor return for our power.

The ideal propeller lies between these two extremes. The ideal prop would work at comparatively low angles at which the drag is still small. This brings us right back to our streamlining. So if you want maximum output for your power, start streamlining. You might have crackups when you begin but when you have the stability pat, you will really begin to notice the difference.

You need not be reminded that poorly outline prop blades, carelessly carved camber, poorly finished surfaces all contribute to the torque because of skin friction, tip whirls and general interference. Some of us still think that working long on a prop is useless effort. This might hold true on gas props where the model is heavier and so producing large inertia force when the model glides into the ground. However, rubber propellers can be made strong enough to withstand all normal landings. Do not be afraid to use 'anchors for Queen Marie' grade of balsa. Besides using tough balsa, be sure to cover the balsa blades with silk and several coats of cement. This will give you all the strength you need.



The carving of a propeller need not be a tiresome chore if the work is done intelligently and systematically. The time will actually be shorter in many cases as the prop will be balanced without trouble. Try the following system on your next carving job: Carefully blank the prop block in pencil. Drill shaft hole while you still have a rectangular cross section to provide a parallel for the drill. Cut the blank to the exact penciled outline. If you did the work carefully, the blank will balance. Next cut the under camber portion so there will actually be no under camber, but a flat surface. Now mark with pencil line the point of deepest camber, about 85% from the leading edge. With the point of the knife cut-in very slightly along this line, and be sure to match both blades equally. Now cut out the front or the 85% portion to this cut-in. When the front portion is cut deep enough, cut away the trailing or the 65% portion. You cannot help but get the correct undercamber. The prop should now be in balance, with both blades having identical undercamber characteristics. The lower camber can be completely finished with sandpaper. The upper camber is guided by the lower. As soon as you come to the dangerous thickness, stop, and start carving a slice at a time with in-between feeling with fingers for the blade thickness. You will be surprised to find how well your fingers will detect true or false airfoil section. The final steps as with ordinary haphazard carving.--The results of using this method of definite stages will be a guarantee that your prop has equal camber, thickness, weight and outline of both blades.



The selection of a propeller for a particular model cannot be given in exact rules. We can make formulas galore but they will only serve for particular designs. As with other things, best process is to keep a note of combinations which worked good.

FREEWHEELING

The drag developed by a freewheeling is surprisingly high. Just remove the prop, glide the model and note the difference. This is as it should be expected since some rubber model props have blade area almost 10% of the wing. It takes power to turn such props over. The roughly finished props, or those whose freewheeling presses them against the nose plug will naturally have the most drag. And the only means of overcoming drag is to nose the model down to develop sufficient speed for glide. So, keep away from freewheelers that use a spring in the front to pull the shaft out. Also use ball bearing washers between the prop and plug.

PUSH-PULL SPEED MODELS

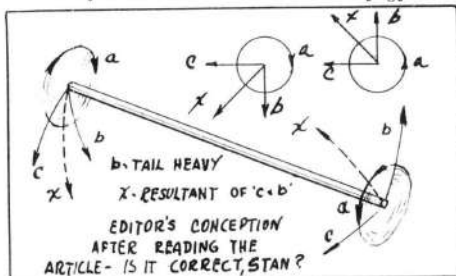
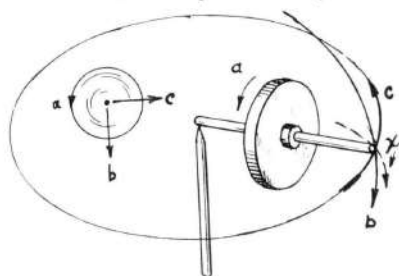
by Stanley Clurman

There are two general arrangements for Push-Pullers, i.e., each prop with its own power, or each prop at the opposite end of the same rubber motor. The first type seems preferable at first glance since it permits a fuselage of normal length. But it requires a special winder to wind both motors in same direction, or each motor must be wound individually; too bothersome when handling high power. The second type is the one I have been experimenting.

My first model was a fuselage which is shown somewhere in this book. It was for a local contest which stipulated ROG and $L^2/100$. The cross section rule worked hardships since the second type must have a long body to have any motor duration. A body that is, proportionately, very long has a large moment of inertia, or a great decentralization of weight. The greater the moment of inertia, (even if body has same weight) the greater will be the tendency to resist rotational motion. If such a model is perfectly adjusted and it is launched correctly, it will keep its course with amazing tenacity. But if it's at all out of adjustment and goes into a stall, and then a dive, don't expect it to straighten out with ordinary tail surfaces. In heavy models with "super" long fuselages if a dive after power is to be avoided, the following precautions must be taken

1. The model must balance exactly.
2. Despite the tail moment arm of almost twice the normal length, the stab area must be greater rather than smaller than normal. It may even have to be 80% of the wing area. This is all because of inertia of the long nose.
3. The C.G. must be very much below the line of thrust.

Another factor which is of specific importance to Push-Pullers is what Mr. Grant vaguely calls "counter-gyroscopic force". The nature of this force, the true name of which is "precession", is as follows (you can observe it on a toy gyro.):



If a wheel is spinning in direction 'a' and a torque is exerted in direction 'b' the resultant of the two forces will cause the axle to rotate, slowly perhaps, in the horizontal plane 'c'. In this case the torque 'b' is the wheel's own weight. This phenomena is just as I have sketched it here. If the wheel were not spinning and the axle was supported on just one end, the other end would naturally drop and the whole business fall off the pivot. However, if the wheel is going at a high speed you will have the astonishing sight of the axle, instead of dropping off, spinning around and around.

The reason this is so important to Push-Pull speed models is that the propellers have a very high speed and therefore greater processional force. Also both propellers exert this force so as to complement each other and so causing the plane to turn and because of the long moment arms they are very powerful. One quality necessary in a Push-Pull to overcome this force is a large amount of side area. For instance; fill-in the landing gear struts and increase fin area so as to bring the Centre of Side Area back of the C.G. This procedure will tend to keep the course straight even if it is flown cross wind, while merely a large fin will cause the job to kite into the wind. Now, remember that precession isn't brought into play unless some disturbing torque is brought to bear on the fuselage.

Here is the trouble I had, both on fuselage and stick designs, the weight of the rubber was so great that, even though the C.G. of the rubber was only a short distance behind the wing, it took an awful lot of clay to balance it. When I saw about an ounce and $\frac{1}{2}$ of clay and lead being fixed to a 60 sq.in. job which already had 4 ozs., I began to slow down. The result was that I was trying to fly a tail heavy model with a positive tail---and it was awful to watch each time the power went out. That is not all, though. The tail heaviness was the torque which caused the body to 'precess' with the result that the model kept swerving to the right even with the rudder set a few degrees. At the contest in which I used the fuselage model, I managed to have the model go upwind with a speed greater than the winner. However, I kept adding power, thus increasing the tail heaviness and 'precession', and when time came to fly downwind, the "dachshund" couldn't hold the course. Therefore, it is evident that the model must be balanced.

So much for stability. As far as the efficiency goes, the push-pull offers the advantages of a twin pusher or tractor but none of their drag. I am positive that I can get a Push-Pull to go 80 m.p.h. over a fairly long course. First would come a change in the props. Those I used had too much area and diameter. The seemingly high pitch is really efficient, in fact I would increase the P/D to 1.8 or even 2.0. For we know that pitch alone does not determine efficiency. It is the kinetic angle of attack of the blades to the air which is important.

θ = Angle of blade (disregard helix temporarily and consider whole blade at same angle as tip)

β = Angle blade advances through to make actual pitch

$\varphi = \theta - \beta$ = Angle of attack of blades to airflow

H = Theoretical pitch V = speed of plane

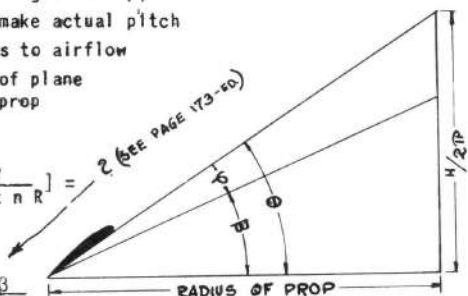
n = R.P.M. of prop R = Radius of prop

$$\theta = \tan^{-1} \frac{H}{2\pi R} \quad \beta = \tan^{-1} \frac{V}{2\pi n R}$$

$$\varphi = \theta - \beta = \left[\tan^{-1} \frac{H}{2\pi R} \right] - \left[\tan^{-1} \frac{V}{2\pi n R} \right]$$

$$\tan^{-1} \frac{nH - V}{(2\pi R)^2 n + HV}$$

$$\text{Efficiency of props} = \frac{\text{Actual pitch}}{\text{Theoret. Pitch}} = \frac{\tan \beta}{\tan \theta}$$



The efficiency of the props I used was about 70% which is not bad. The excessive area absorbed too much power though. I would use 6" props with a P/D of 2.0 or 7" props with a P/D of 1.8. Both would have very little blade area. The next plane would be a "flying broomstick" as shown. The surfaces would be built up to take off some weight. The boys taught me to make speed jobs light! Lastly the nose would be just as long as the tail so that I could change power without affecting the balance.

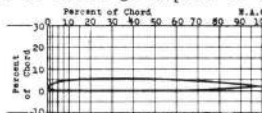
I wish to call your attention to the airfoil used, the Ramino 7, because of its remarkable adaptability to speed models, where as we know, accuracy in airfoil is more important than on regular rubber jobs. The wind tunnel test of the model was at 98.4 ft./sec. (66.7 m.p.h.) which isn't any higher than some of the good speed models can do. The airfoil has an L/D of 25 at 5° although the C_L is low as you would expect on a speed airfoil. It is the most stable airfoil I have ever seen. From 15% of the Chord at 2° , the C.P. moves to 33% at 16° ! It lends itself to construction easily since it is flat on bottom from 0.05 to 0.60. --Speed models should have a minimum flying speed of about 30 m.p.h. if speeds of 60 to 70 m.p.h. are to be top. As per:

$$V = \sqrt{\frac{W}{A K_y}} \quad \text{or} \quad A = \frac{W}{K_y V^2}$$

V : Minimum flying speed

W : Weight of plane

A : Wing area K_y : Lift coef. (C_L) at inc. used



N.A.C.A. REFERENCE NO. 757

α	DP/R	L/D
0	1.80	1.90
2	3.95	0.30
4	3.80	0.36
6	4.30	0.30
8	4.80	0.30
10	5.10	0.30
12	5.55	0.30
14	6.80	0.30
16	8.00	0.30
18	8.50	0.30
20	9.80	0.30
22	9.80	0.30
24	9.80	0.30
26	9.80	0.30
28	9.80	0.30
30	9.80	0.30
32	9.80	0.30
34	9.80	0.30
36	9.80	0.30
38	9.80	0.30
40	9.80	0.30
42	9.80	0.30
44	9.80	0.30
46	9.80	0.30
48	9.80	0.30
50	9.80	0.30
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58	9.80	0.30
60	9.80	0.30
62	9.80	0.30
64	9.80	0.30
66	9.80	0.30
68	9.80	0.30
70	9.80	0.30
72	9.80	0.30
74	9.80	0.30
76	9.80	0.30
78	9.80	0.30
80	9.80	0.30
82	9.80	0.30
84	9.80	0.30
86	9.80	0.30
88	9.80	0.30
90	9.80	0.30
92	9.80	0.30
94	9.80	0.30
96	9.80	0.30
98	9.80	0.30
100	9.80	0.30

Name of section: E. Ramino 7
Size of model: 28.54" x 4.734"
Wind velocity: 98.4 ft./sec.
Where tested: D.C.A.

GEARED RUBBER MOTORS

by Fred Rogerson

During past years much has been written on building of geared motors, along with a few articles on the design of such motors for model use. But what of the application of these motors to our models? Are users of geared motors still up in the clouds or are they afraid to commit themselves on their own experiments. If I may hazard a guess I would say that the former is the case, which would account for the very poor showing made by them in past years.

Neither is it my intentions to offer formula here, or even rule of the thumb whereby you might get proper relations between model and motor unit, but to try to present a new working angle, with which to approach the problem. For the amount of success we get from geared motors, not only depends on the gear ratios used and the amount of rubber, but a very definite relation between the geared rubber motors and the propeller.

Our troubles with rubber motors have also been increased with increase in wing loading last year, since the speed of a model airplane is governed by the wing loading. So that when the wing loading is doubled the speed is increased by about 50%. This compulsory increase in speed demands a higher power output. But to increase the rubber motor from say 2 to 4 oz. would give such a heavy thick skein, that the turns would be considerably reduced. Also during the last year we have gone to extremes in motor length, so that there is little hope of adding revolutions in that direction. Thus, we are forced to look for some other means by which we can retain our turns, increase the power and at the same time try to reduce the tremendous strain on the fuselage structure.

A couple of years ago, while investigating torque curves, for torque delivered at the propeller, on geared and straight drive motors, I became thoroughly convinced that the geared motor was far superior. Different gear ratios have to be used, according to the demand placed on the rubber motors, for models of different weights and performance required. Gearing up reduces the slope of the power curve and increases the turns available. These two facts alone I believe have led many builders to use geared motors, only to come to grief later. If they had investigated further they would have found that, the average torque decreases, as the slope of the power curve decreases, with the result that the useless turns at the lower end of the curve are increased. For instance on 18 strand motor 30 inches long, direct drive, develops 46 in./oz. of torque at 1020 turns, with an average torque of 19 in./oz. Now if we use 2 such motors and gear 2:1, the maximum torque is 45 in./oz. at 2040, while the average torque is reduced to 16.5 in./oz. And from the viewpoint of present design methods, the useless turns are doubled. Since the average torque has been impaired we find it necessary to add two strands to each motor unit, to retain our original average torque of 19 in./oz. Now summing up we have;

- (1) The same average torque;
- (2) Maximum torque increased 14%;
- (3) Stored turns increased 88%;
- (4) Slope of the power curve reduced 20%;
- (5) Stored energy increased 122%;
- (6) The (so called) useless turns increased 90%.

The increase in stored energy alone should be sufficient to sell the idea of gearing, for provided it is properly used, it is sufficient to lift an 8 oz. model to an altitude of 330 feet.

The job we now have is to turn these advantages to actual gain in motored flights. It is necessary that we consider the non-useless turns, if we hope for maximum efficiency or maximum performance per oz. of rubber used. Since the steeper the torque curve in relation to the revolutions per second, the larger we must make our propellers. It follows that we should use smaller propellers on geared motor units where the slope of the torque curve is reduced since the propeller usually stalls first. In well designed models the blade angle should not exceed a theoretical angle greater than 27° at $3/4$ of the diameter from the hub. (On all heavily loaded models, this value or less, has shown improved results on conjunction with geared motors, direct drive not having been tried. This angle gives about a 19.5" Pitch on a 16" Dia. propeller.) In turn this method allows for more climb to be made on the first part of the power curve where we have the greatest reserve of power and more of the so called useless turns to be converted into useful energy. As a matter of fact, I have had pro-

propeller, motor unit combinations, that delivered sufficient power for climb until practically the last turn. The power duration is not greatly affected by this type of propeller, due to the extra turns made available, while the altitude gained is considerably greater in most cases. Propeller and motor or motor units, are much more closely related than are the model and propeller, and I think builders would do well to consider this fact when laying out a new propeller. The best torque value for a given model can be determined approximately by the formula $T = A \times L \times 10$ where T = Maximum torque, A = Wing area in sq. feet L = Loading in Oz. per sq. ft., 10 = a constant. Maximum torque is controlled by the number of strands rather than the weight of motor. The above being true, it is quite apparent that the diameter of a propeller should be in relation to torque curve and indirectly in relation to the wing loading, rather than in relation to wing span.

Figure 1 shows four relative power curves for various geared motors.

Figure 2 shows the method and equipment used for testing the torque of the motor.

The Terms R_m and R_p are revolution for motor (or rubber) and revolutions for propeller. The Average Torque is determined by adding, in a vertical column, the maximum torque and torque values at each 100 turns down to zero. Divide the total by the number of readings taken.

My preference is for a shorter motor run and high altitude. Theoretically a low altitude and long power run plane has a slight advantage. In practice, however, their flights are approximately the same, with any wind or thermals in favor of the high climb job. However, the terrain over which the model must fly may show large advantages in favor of either. All of which tends to bring in conflicting reports of various types of performance which is all very confusing. But having flown on the same ground now for four years, under all forms of weather conditions, using direct drive and various gear drive combinations, combined with fast and slow climb performances, all on the same model, I feel that my comparison of results are quite reliable.

I would say that an automatic pitch adjuster would be an aid to geared motors in particular, provided, of course, it really worked. I have been working on such a device for 2 years, which would just give the thrust required for a predetermined performance of the particular model. About a year ago, I had it to work as I had desired, absolutely no stall present regardless of the position the model assumed in the air and no altitude lost on the down wind side of a circle. The tension of the rubber had no influence on the pitch with this arrangement. The springs which held the adjustment, however, were so delicate that after a few flights, they were hopelessly bent and the blades out of adjustments. Since that time I have been trying to design a much more positive means of adjustment with only one spring.

When fitting a power unit to a model, rubber should first be considered. First, the weight of the rubber. Second; the length of motor or proper gearing (both reducing the slope of the power curve) to reduce the power curve to where a very little or no sharp burst is present on the top end. Third; a propeller design that will climb the model for $3/4$ of the length of the power curve. The balance of the curve going to level flight. The useless turns being a very small percentage on such an arrangement.

GEARED MOTORS

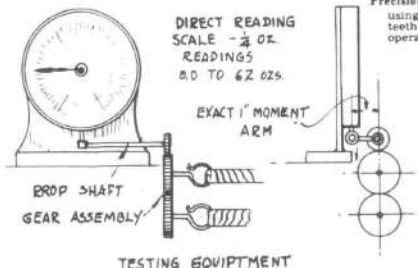
Precision Built to Your Specifications
using special cut gears having 39
teeth to the inch for smoother
operation.

77 teeth on a $1/8"$ gear.
Six Types of Stock Motors to Choose From

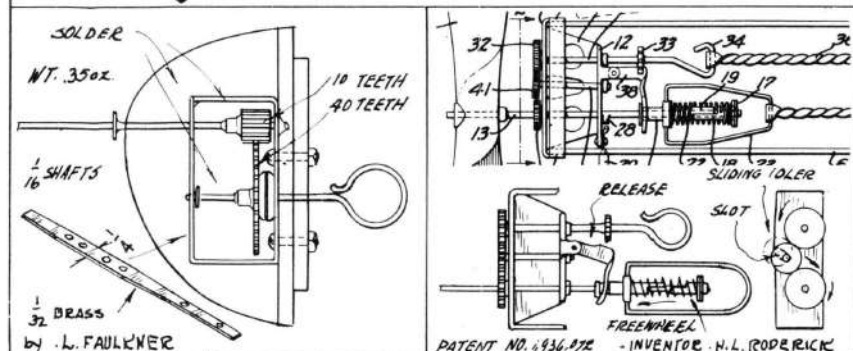
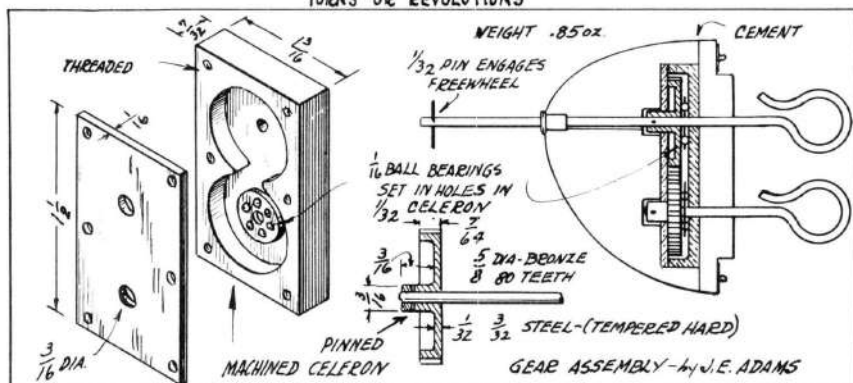
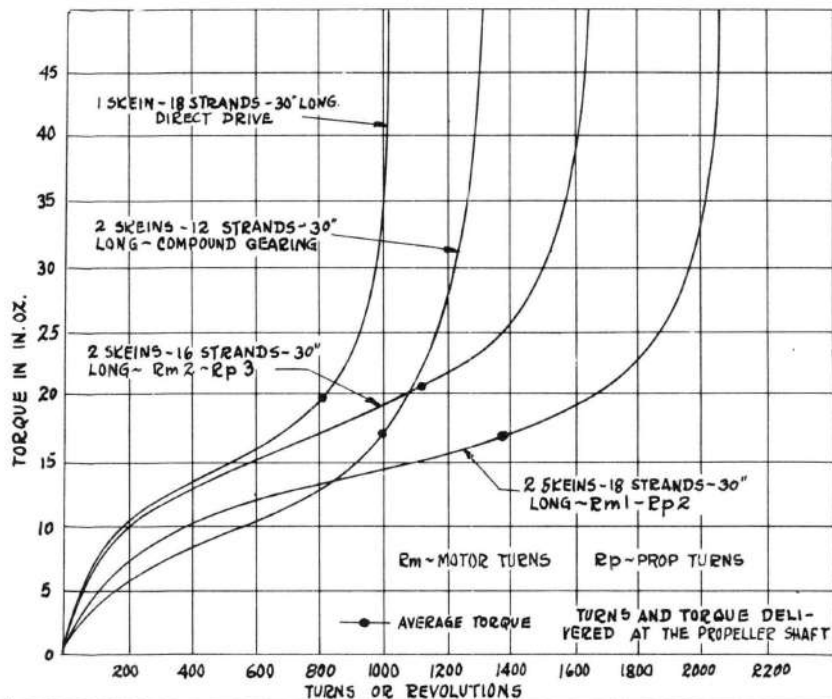
For details or advice, write to

FRED. J. ROGERSON

10 Locke St. N.—Hamilton, Ont.



Mr. Roderick's invention has been improved since patent was granted. Actual flight tests proved its value; upper motor coming in just at the right time for another burst of climb. Not yet manufactured. All parties interested in manufacturing this device, please contact Inventor c/o Editor.



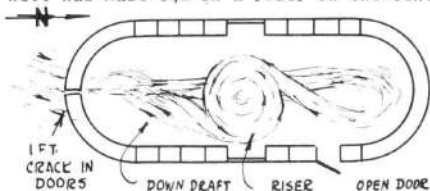
INDOOR THERMALS

by Rod Doyle

The Junior Birdmen indoor contest came to a dramatic conclusion yesterday and I am very much afraid that Rich will be suffering from a headache today. Poor fellow had a good chance until the weather man dished up a storm, with a wind up to 30 m.p.h. and rain. It was quite cold outside too.

We got there at 7 A.M. Unpacked and tested gliders by 7:30 Rich got 46s then 50s and finally 52s with his glider. We couldn't believe it so we checked the watch which was OK. We attributed the high time to the super-finish. Little did we know what was in store for us.

The glider event started at 9:30 and soon a word drifted around that Birkett had made 64s on a riser in the center of the hanger. Here is a drawing of



the place to make it clear. The cold wind came through the South door, rushed to the North end, backed up to West across the hanger where it was warm enough to rise. Then travelled South towards the door where it cooled, causing a down draft. The riser was not very noticeable, but strong enough for about 8 flights over 1 minute.

78s was tops, Second placed with a 12 oz. outdoor glider with time of 64s. Third place tied three ways with 63s. Then 54s, and Rich 53s for 5th place!

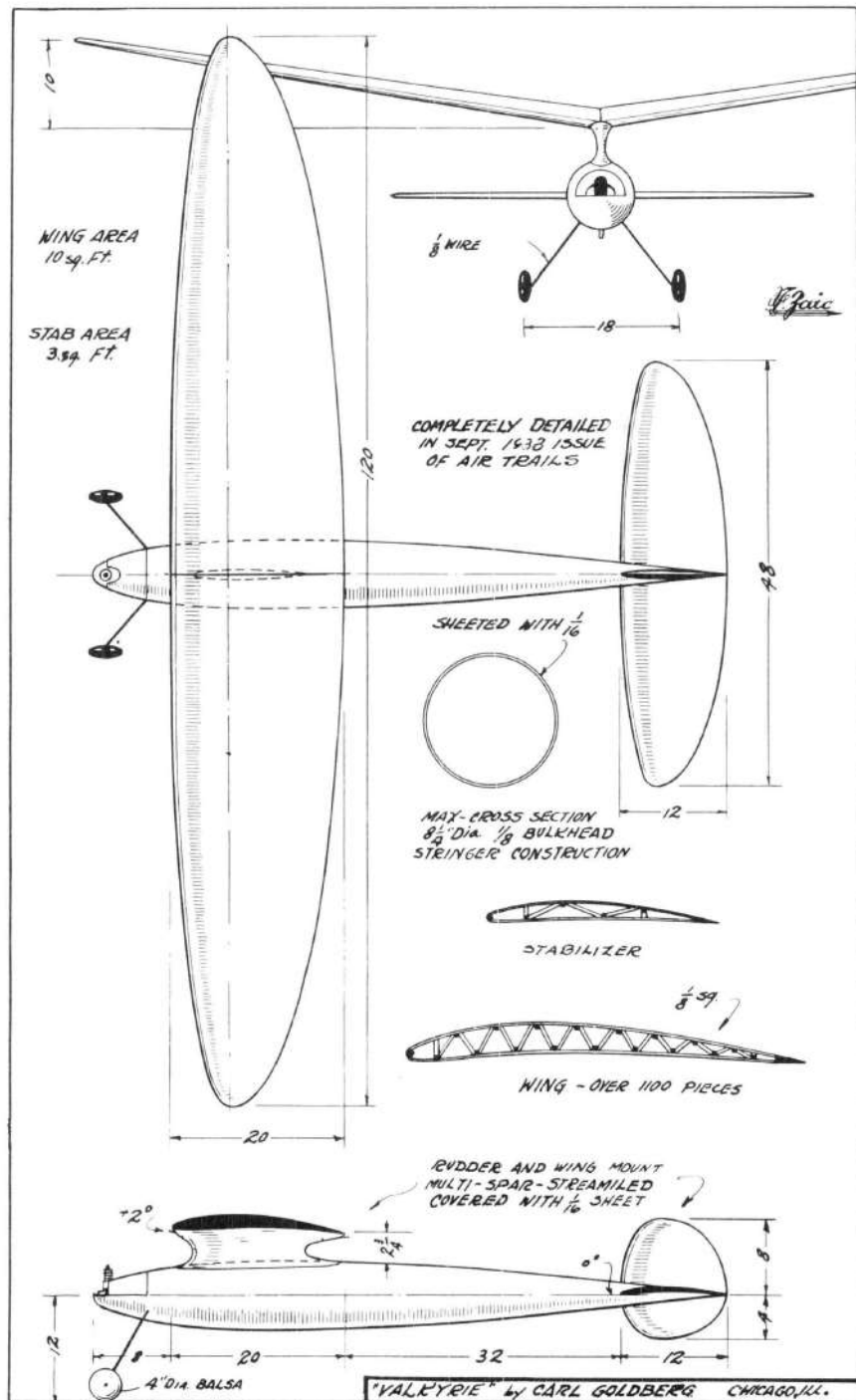
At 1:00 the side door was closed and the place was not so drafty. In the stick event Parker got 13m 10s. Rich had two flights caught in rafters, 1st after 10m and second after 9m; both good for 14m. We cleared his stick off for another trial just as the whistle blew. It messed around in a down draft, no climb at all, and was down to about 30 ft. at 5m approx. Rich was disgusted and walked over to the sides to get the cabin job ready. Just after he left, the stick caught a riser and went up to about 75 Ft. high and ended up with a flight of 12m 40s for 3rd place. Parker won with Connie Thorall 2nd with 12m 50s.

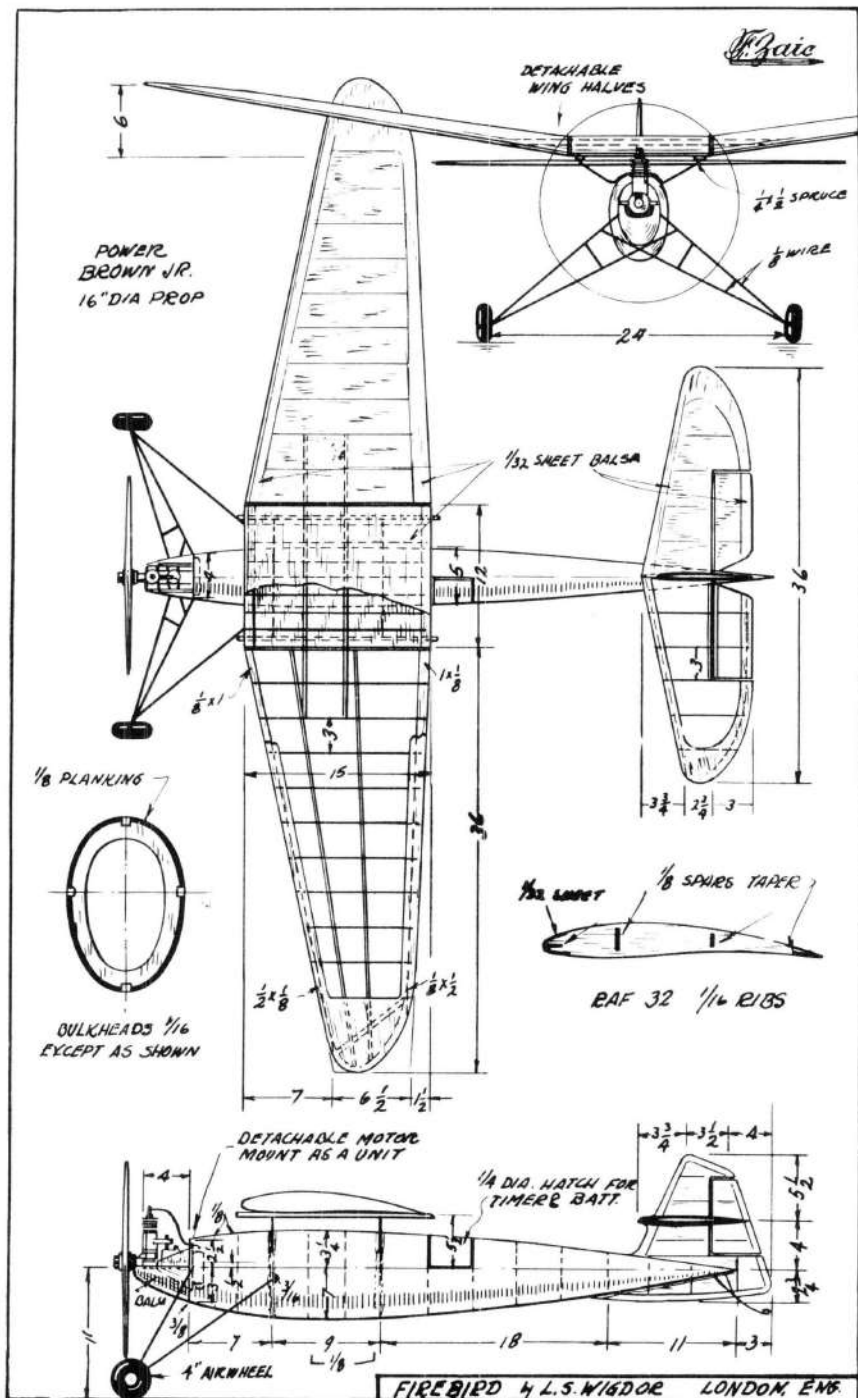
During the Cabin event the lights were turned on and this made the risers stronger yet. You may not believe it but I can safely estimate them at up to 6 ft./sec. in this event. Rich got his in a riser going up to about 150 Ft. then drifted South for about 400 Ft. to the other end of the hanger, ending in a down draft at 8m. At the same time Thorall put his up for 13m; 3/32 rubber on 12" prop a good combination for maximum of 9m. It dead stuck at about 75 Ft. up and was soaring for 3m! It was sure great, alright, every flight hit a riser and it was just a question of how long the ship stayed in it. Rich's cabin made three flights of over 400 Ft. drifting from the center to the South end. He placed 3rd in this event with 9m 50s. Parker second with 10m plus.

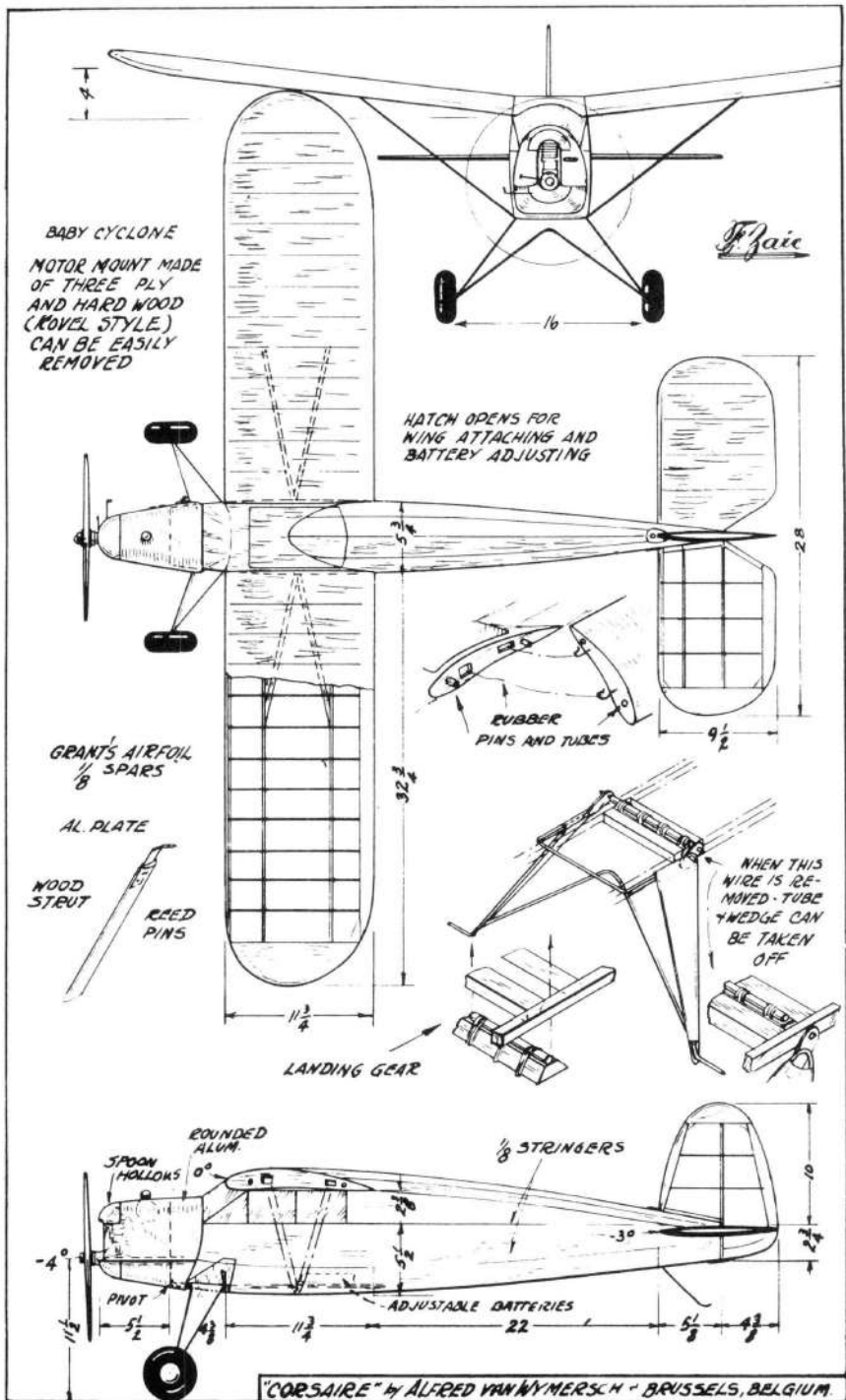
Vernon Parker won the trip on points. I imagine he really deserved as he worked hard for the last four indoor meets and had a lot of bum luck. Of course Rich got a lot of bum breaks but he has not worked as hard as Parker. However, if the conditions had not been so amazing, I am certain that Rich would have won as his ships were well set and had flown beautifully the week before at Sunnyvale. Tractor made 17m.50s and Cabin 10m 55s. Well, that is the way it goes, But I doubt very much if such conditions have ever been seen before in this country.

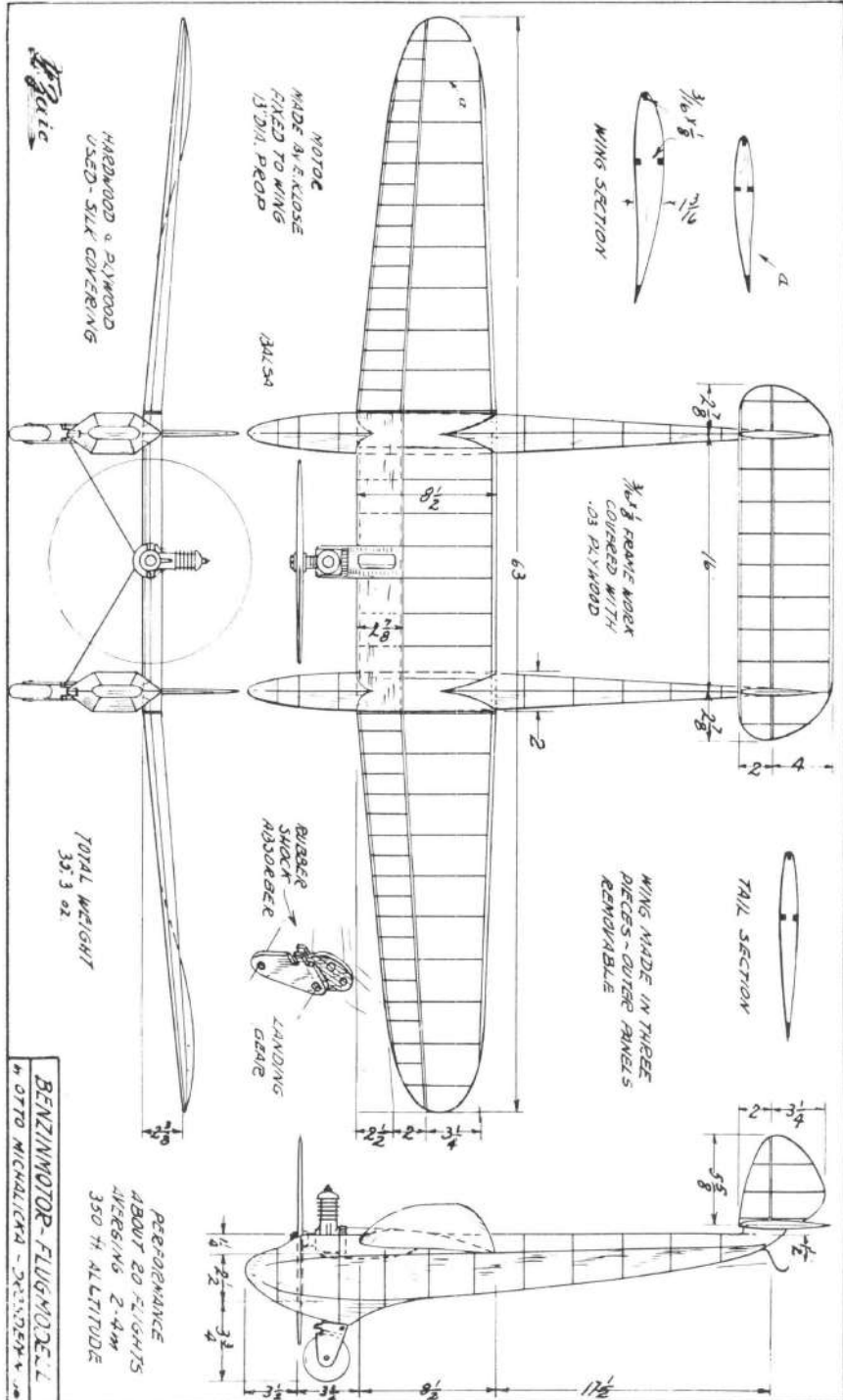
I told Rich last night that I was going to quit the model game and I hope I can as I need the time for more serious work. It is a shame to give up a hobby that has afforded so much enjoyment and won so many fine friends. Lately I have been half hearted about model building, not being really interested enough to build anything decent. However, when a meet approaches I usually get to work at the last minute and patch up the gas job in hopes of winning a meet or so. It is mainly to satisfy myself that I can still keep up with the boys, though I have been beaten enough times to know better by now. I usually wind up 3rd or 4th, sometimes 2nd, always close enough to first to make me think I can beat the boys.

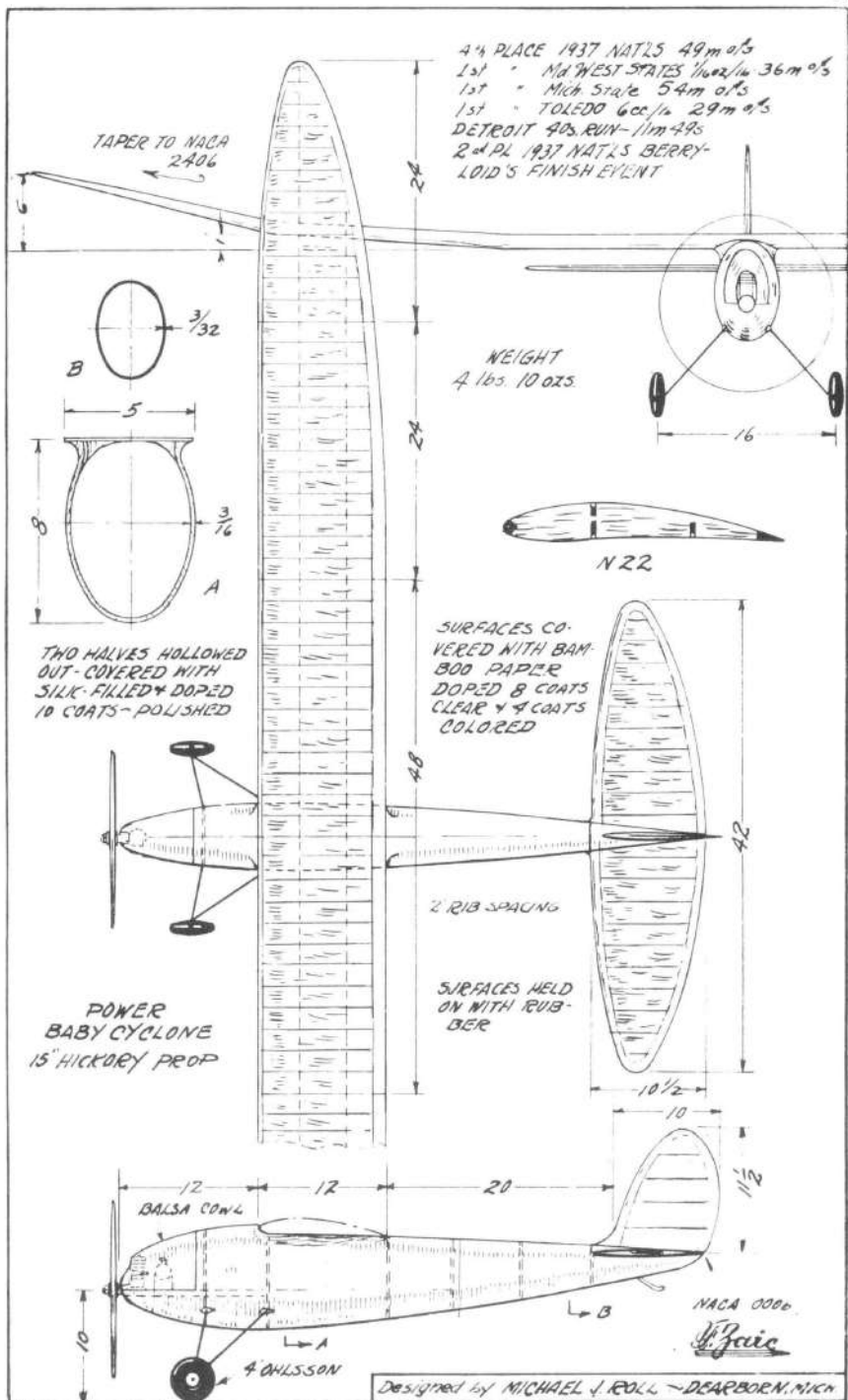
(Rich writes that Rod is messing now with Secondary Gliders.)











CALIF STATE FAIR CHAMPIONSHIP
13m 27s O.G.S. (30s MOTOR RUN)
ALSO NORTH CALIF.
CHAMPIONSHIP

H. Zaic

POWER
OHLSSON

13" DIA. PROP.

LOADED TO 0mg/hr
NO CHANGE IN
PERFORMANCE
3m.T₂ on 15s.M.R.

FILL-IN
SPARE TO

1° RIGHT

COWLING

 $\frac{1}{32}$ SHEET
$$- - 3\frac{1}{2}$$


700 mm

BACK VIEW OF
1/8 BULKHEAD
BACKED WITH
1/4 x 3/8 PINE

5 SOL. WASHER

MOTOR MOUNT
1/16 SHEET ALUM.

FIRST TWO RIBS IN
STABILIZER ARE $\frac{3}{16}$
HIGHER ON TOP SHAPE
TO A SLIGHT ANGLE

STAB*RED. $\frac{1}{16} \times \frac{3}{8} \times$ CLORD RIBS

Hand-drawn diagram of a fuselage section with the following specifications:

- Overall length: $4 \frac{3}{8}$
- Cap dimensions: $\frac{3}{4} \times \frac{3}{16}$ CAPS
- Sheet dimensions: $7 \frac{1}{8} \times \frac{1}{16}$ SHEET
- Plug dimensions: $\frac{1}{4} \times \frac{1}{4}$
- Plugs at ribs: $\frac{3}{32}$ PLUGS AT RIBS
- Rib spacing: R.A.F. 32- $\frac{1}{16}$ RIBS

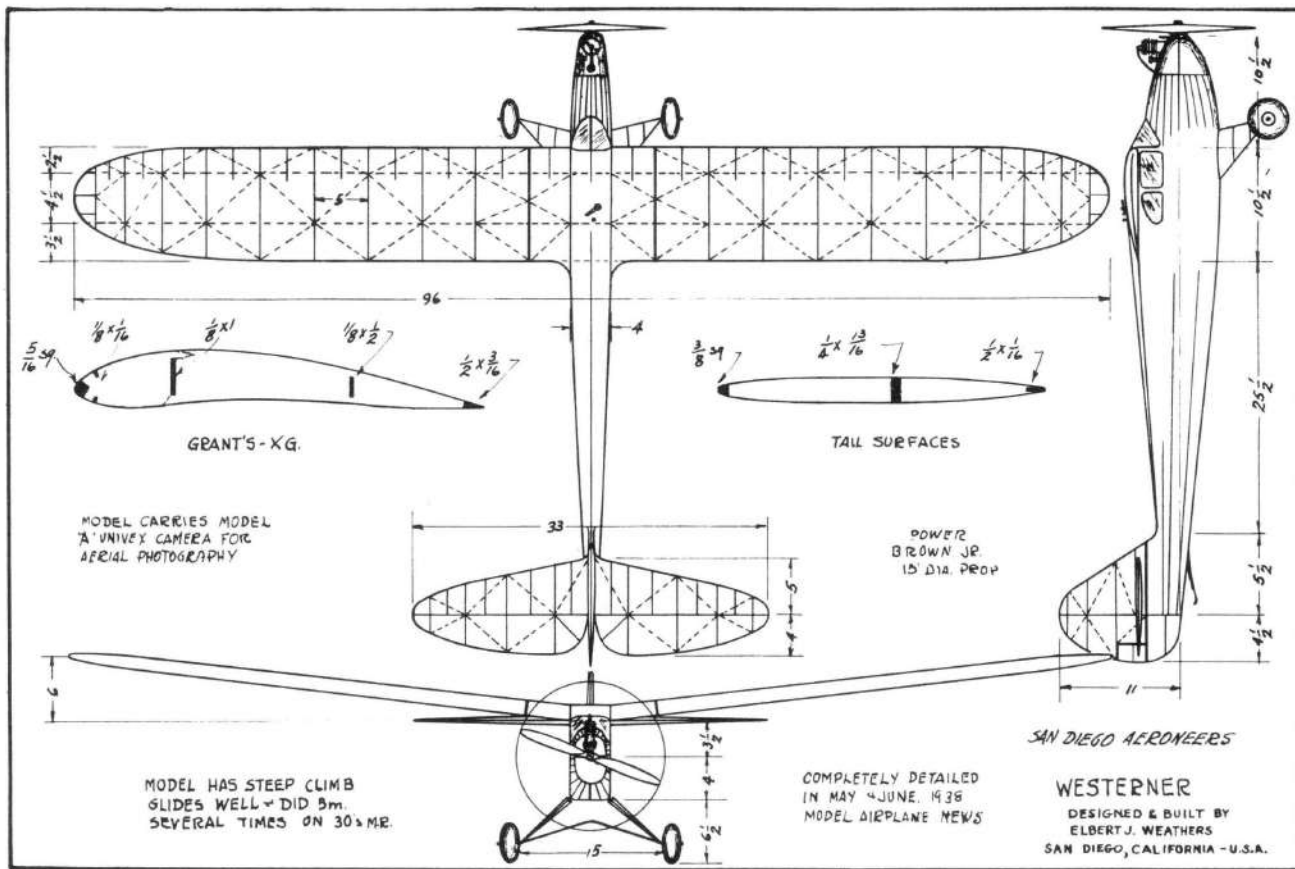
LAMINATED
TIPS

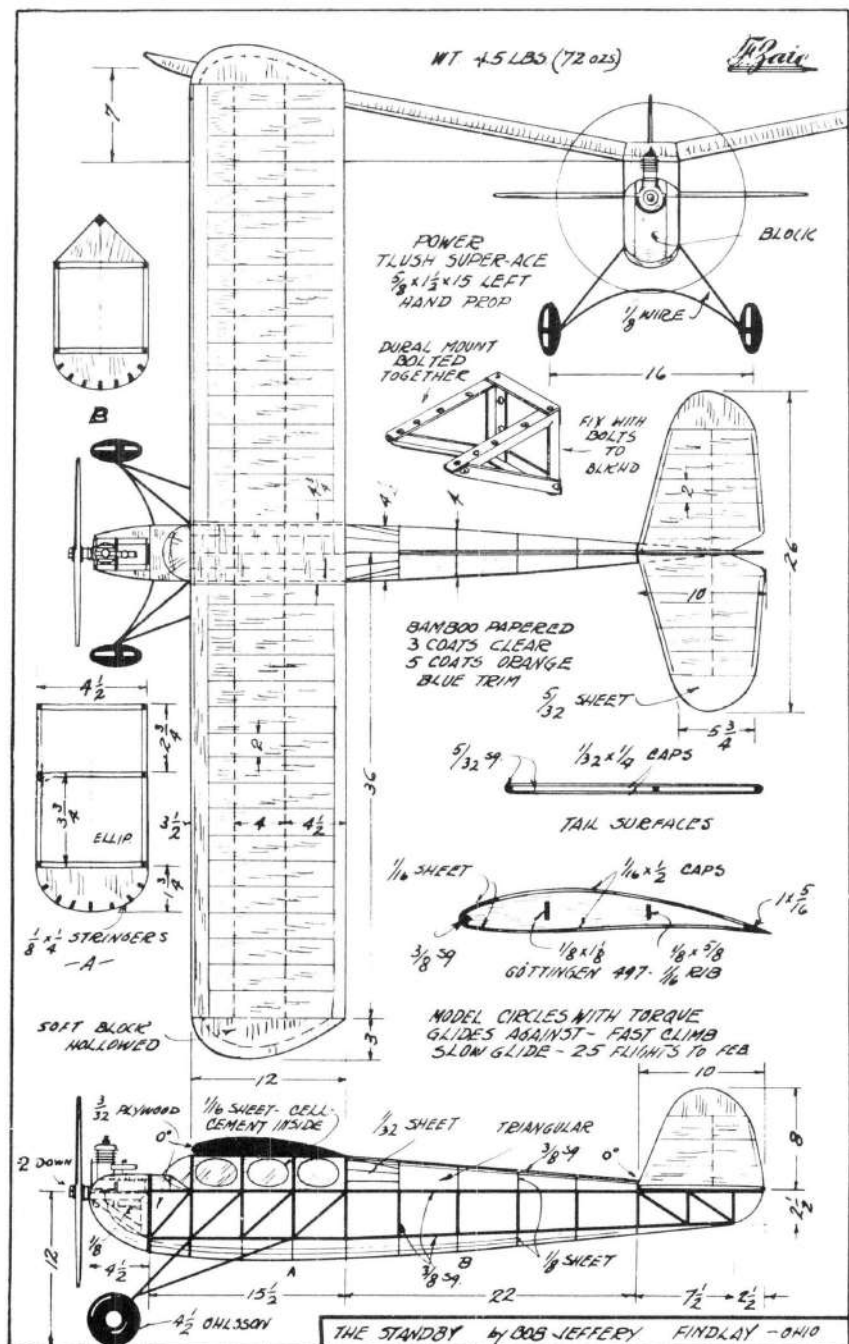
COVER WITH $\frac{1}{4}$
SWEET

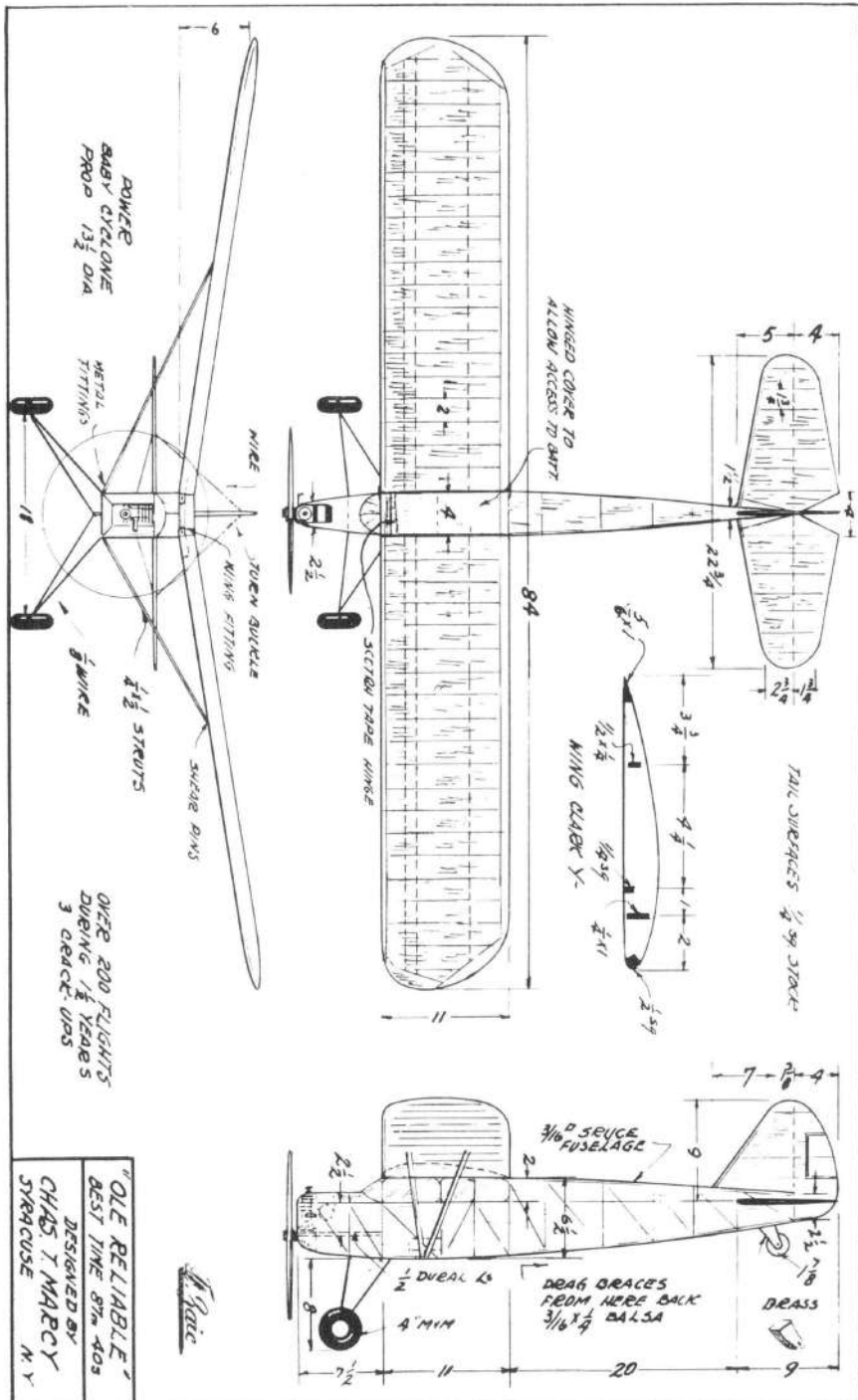
FRAME

ALUN.
SKID

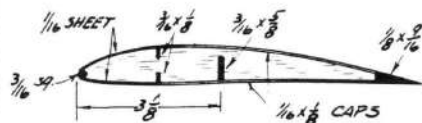
THE ETHY by RICHARD SCHUMACHER - OAKLAND, CAL



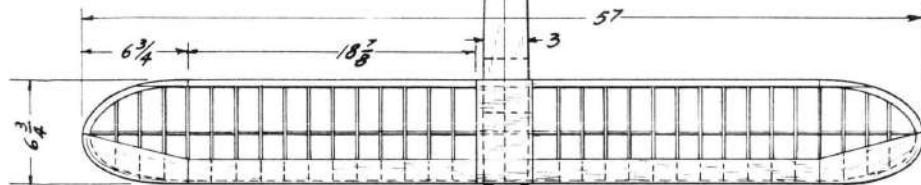




TAIL SURFACES
STREAMLINED



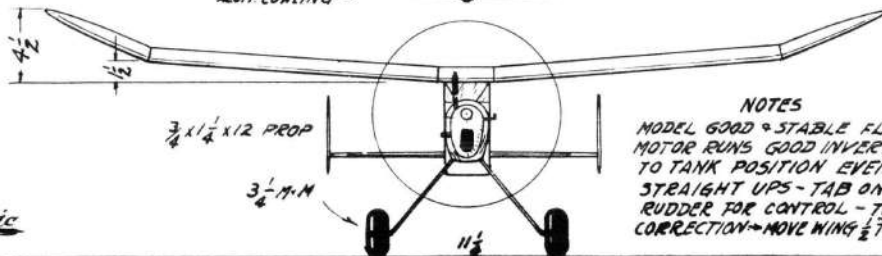
WING RAF-32



MODEL WT. 1.75 lbs
ALUM. COUPLING

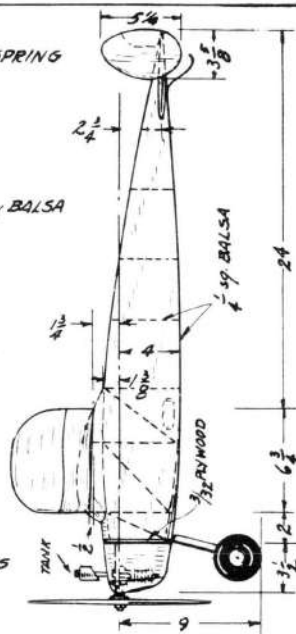
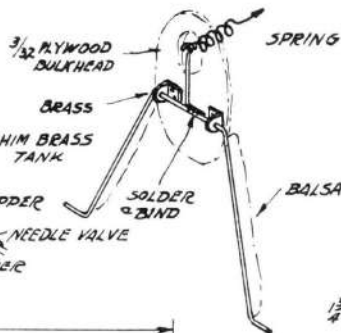
RIGHT →
POWER
BABY CYCLONE

10% ON 3m. M.C. DE-
SCENDED OVER WOODS



NOTES

MODEL GOOD & STABLE FLYER
MOTOR RUNS GOOD INVERTED DUE
TO TANK POSITION EVEN ON
STRAIGHT UPS - TAB ON LEFT
RUDDER FOR CONTROL - TORQUE
CORRECTION - MOVE WING 1/2" TO RIGHT

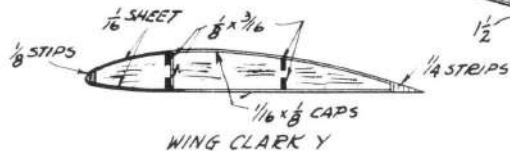


FULL SIZE DRAWINGS
AVAILABLE - \$1.00

TWIN CYCLONE

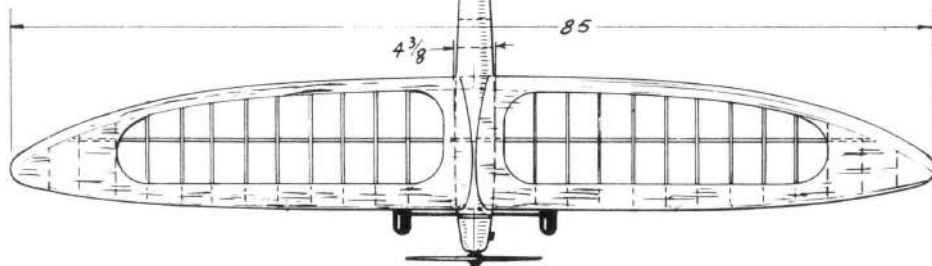
Designed by
J. TOM LAURIE
FT. WAYNE IND.

TAIL SURFACES ARE
STREAMLINED - STAB
HELD BY DOWELS &
RUBBER INSIDE FIN

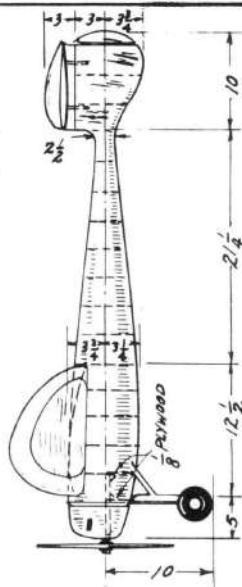


THE FUSELAGE IS MADE
IN TWO HALVES ALONG THE
THRUST LINE - PLANKED IN
HALVES

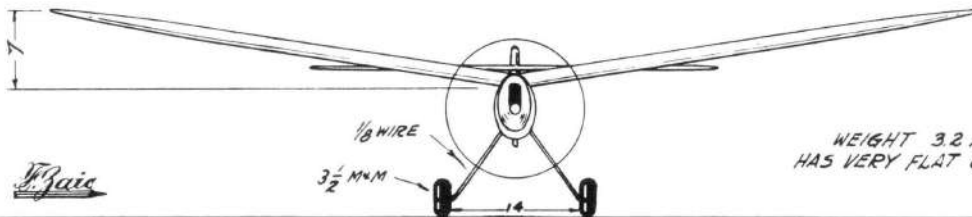
1/8 LAM. BALSA
BULKHEADS
SOFT BALSA
PLANKING



POWER
BABY CYCLONE-13 "PROP



MOTOR BEARING
HARDWOOD FIXED
TO TWO 1/8 PLYWOOD
BULKHEADS

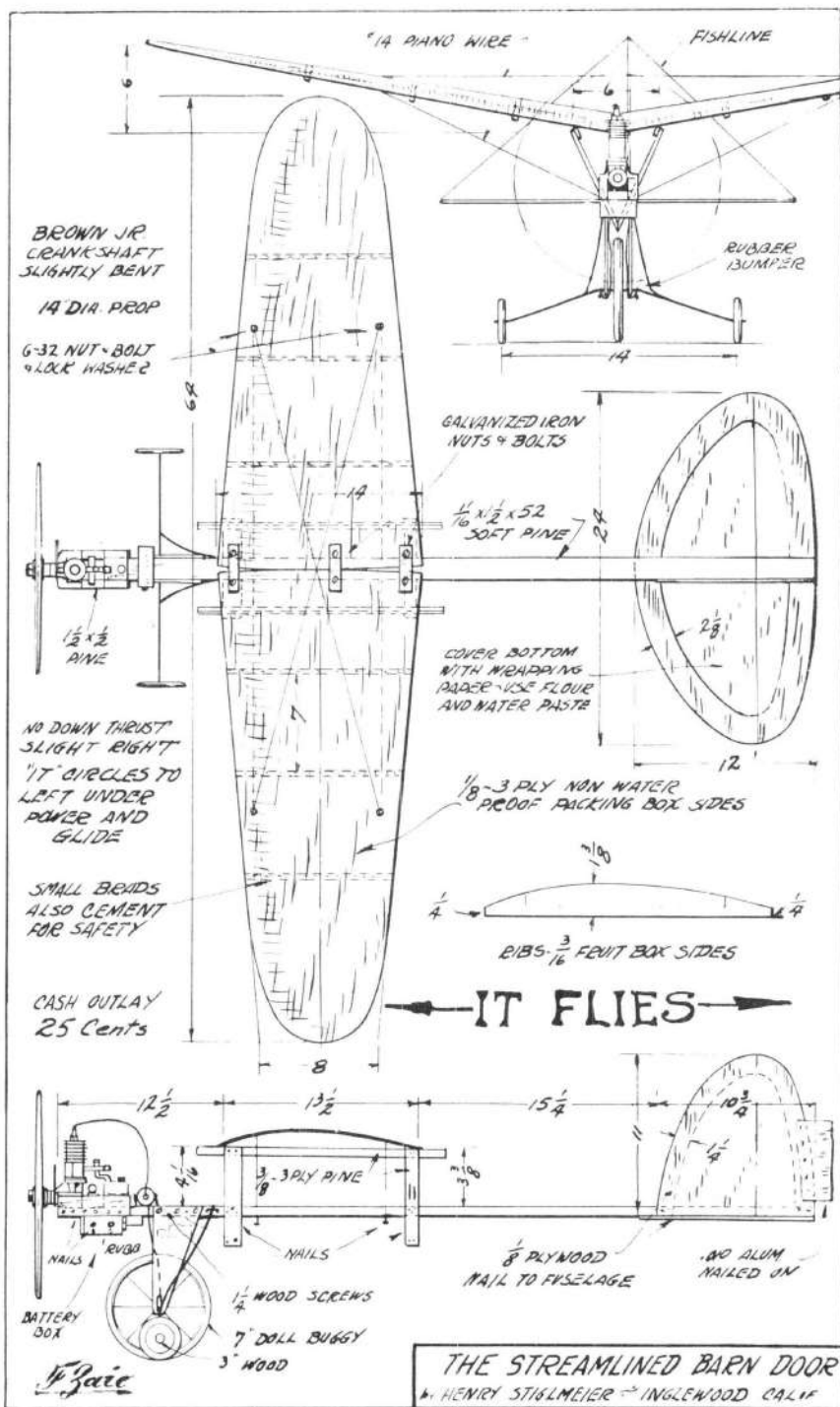


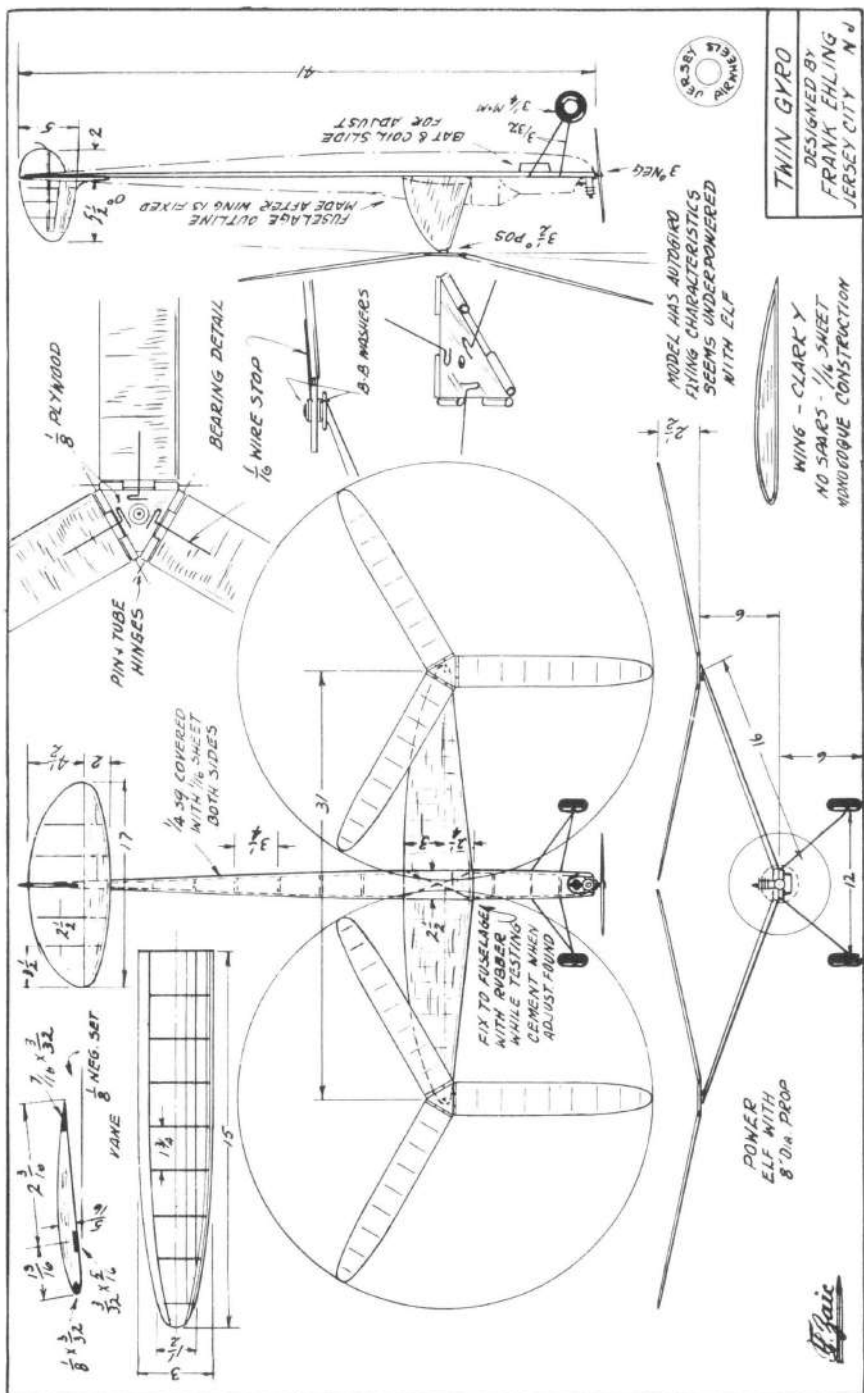
WEIGHT 3.2 LBS
HAS VERY FLAT GLIDE

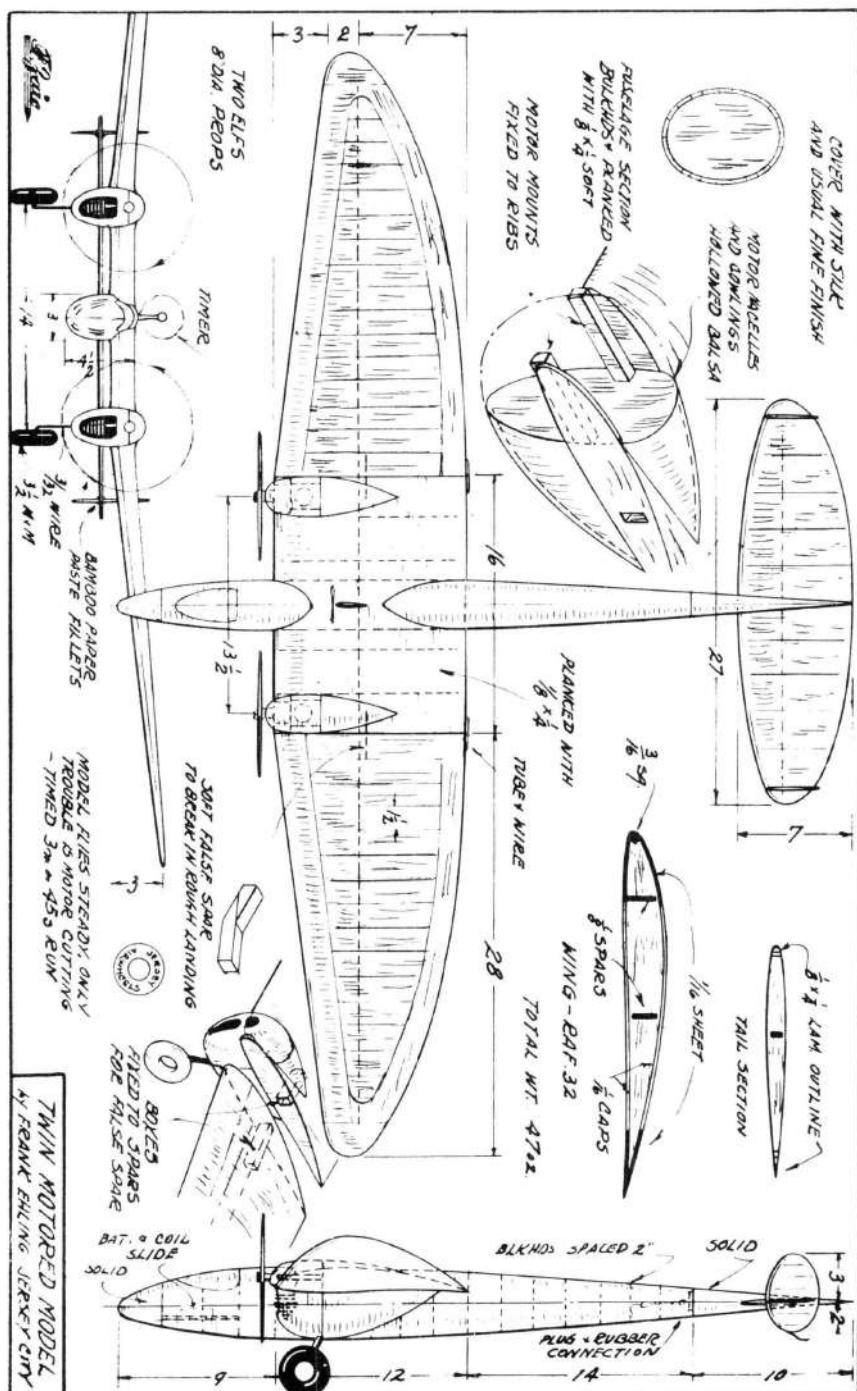
EXPERIMENTAL

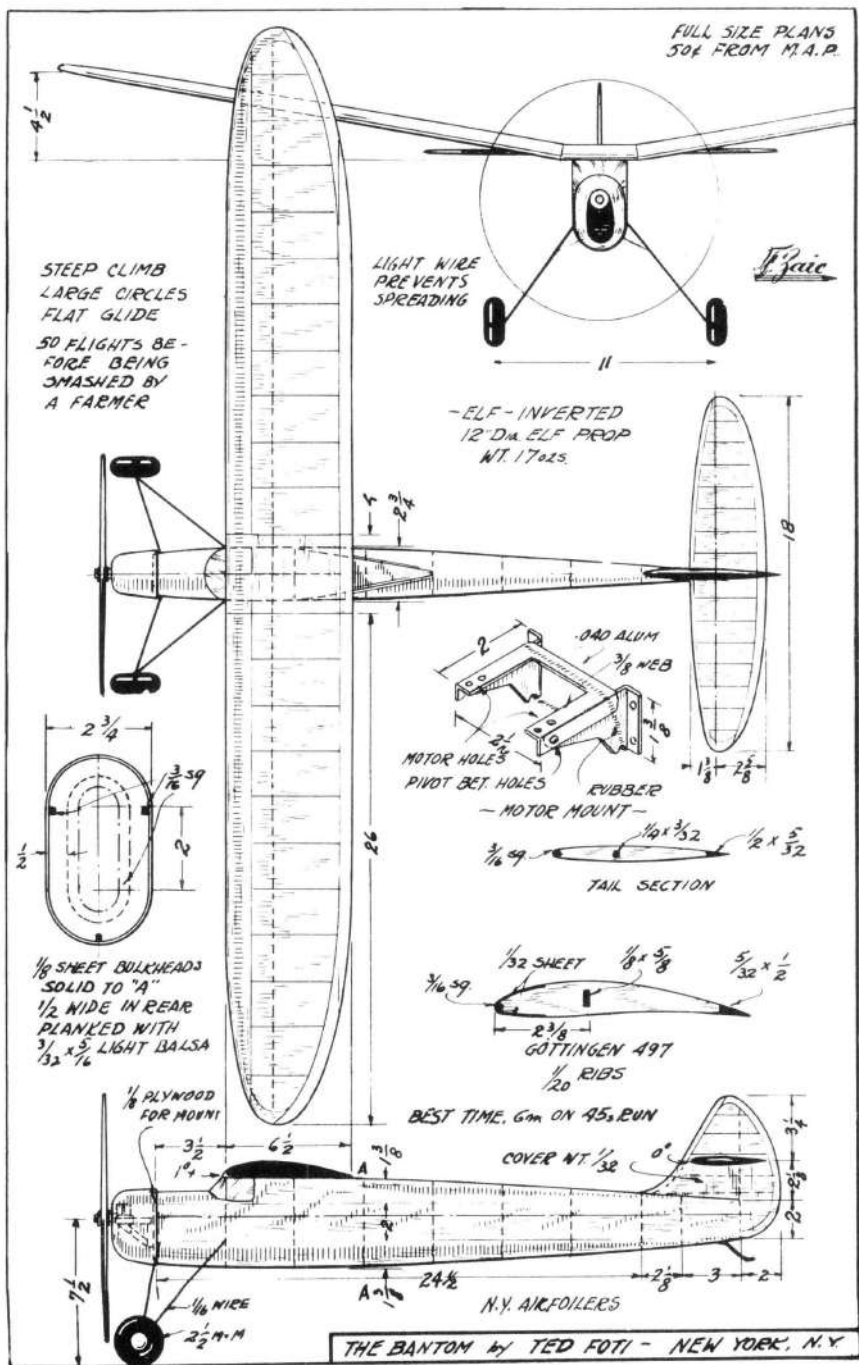
by J. TOM LAURIE
FORT WAYNE IND

J. Tom Laurie

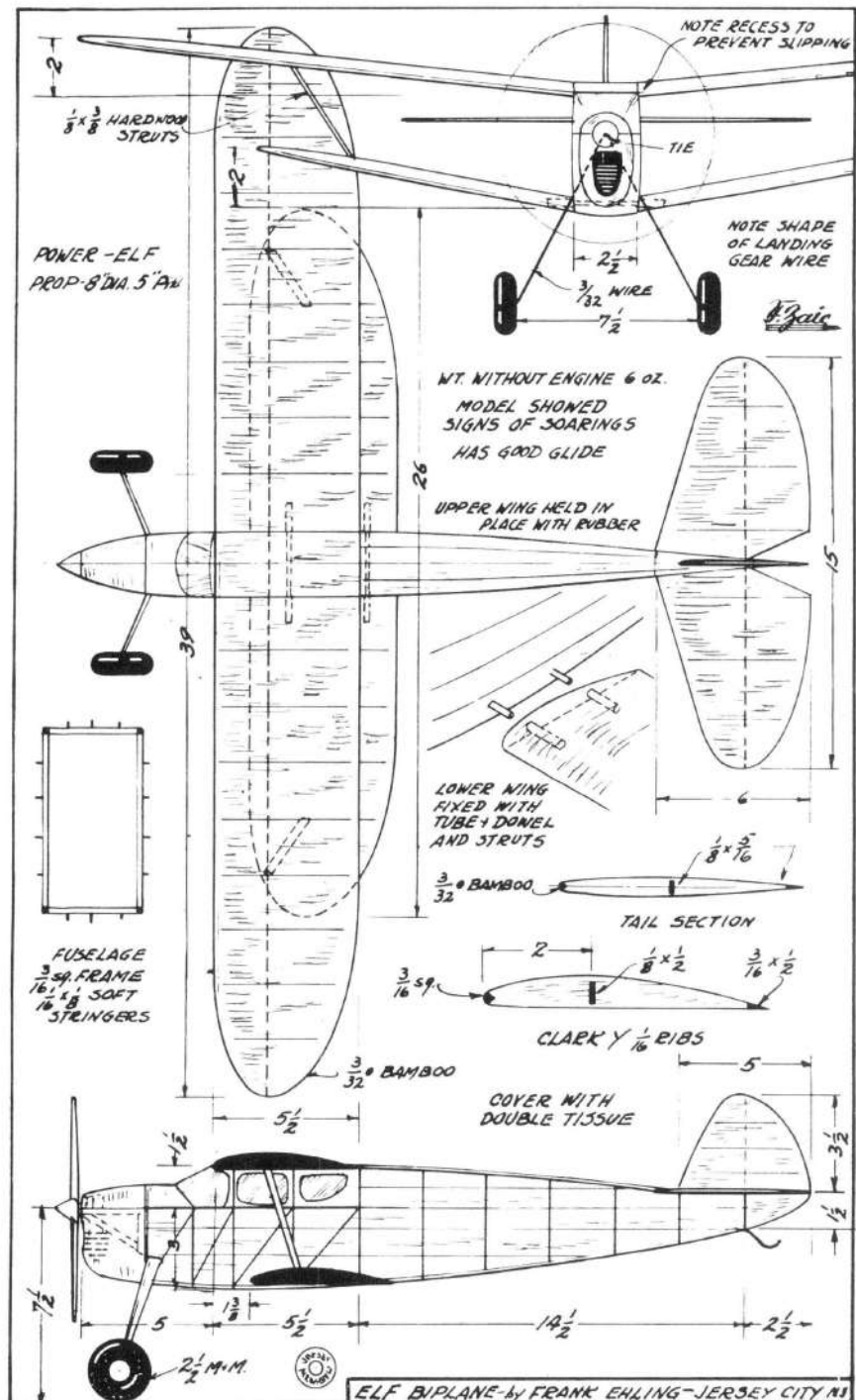


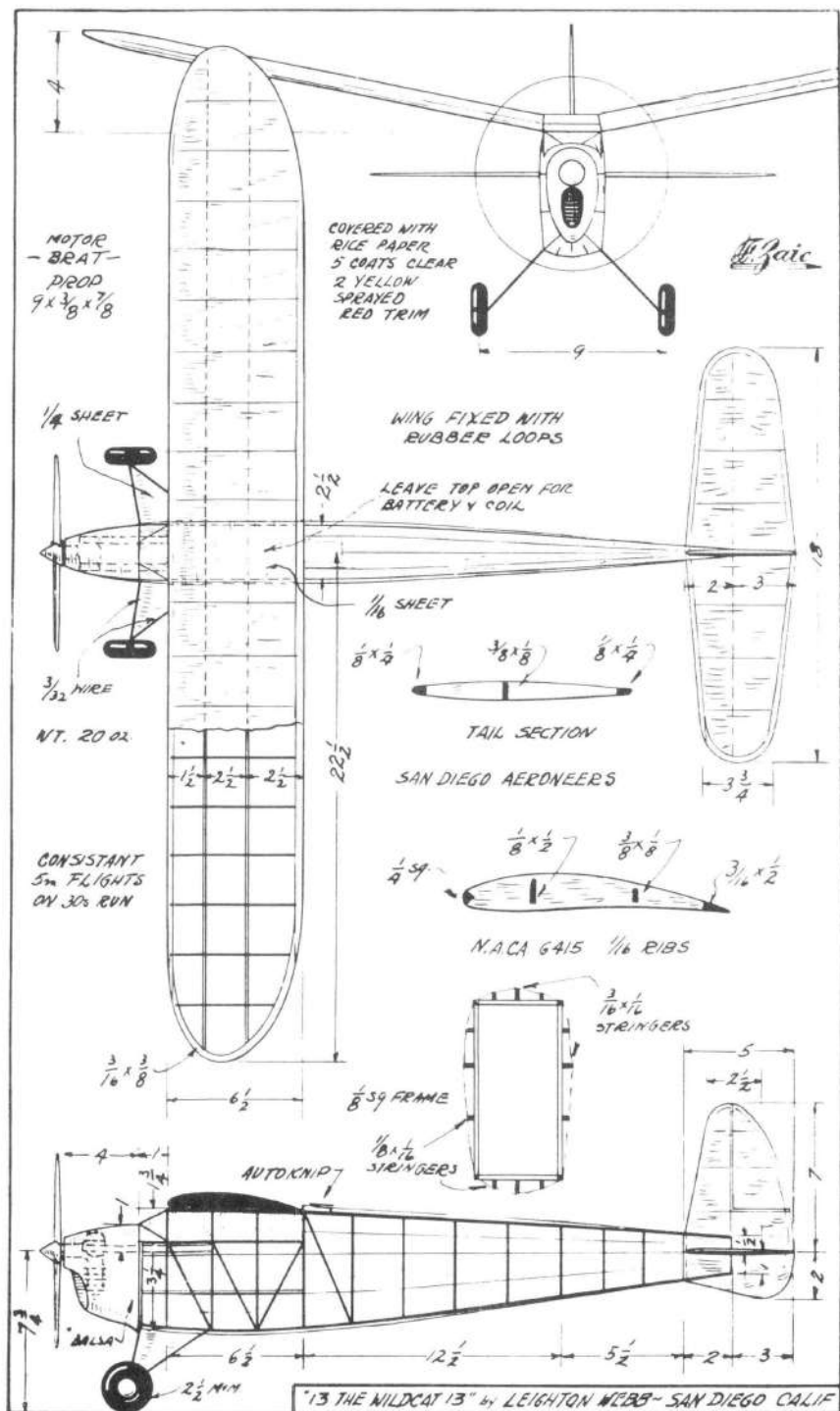


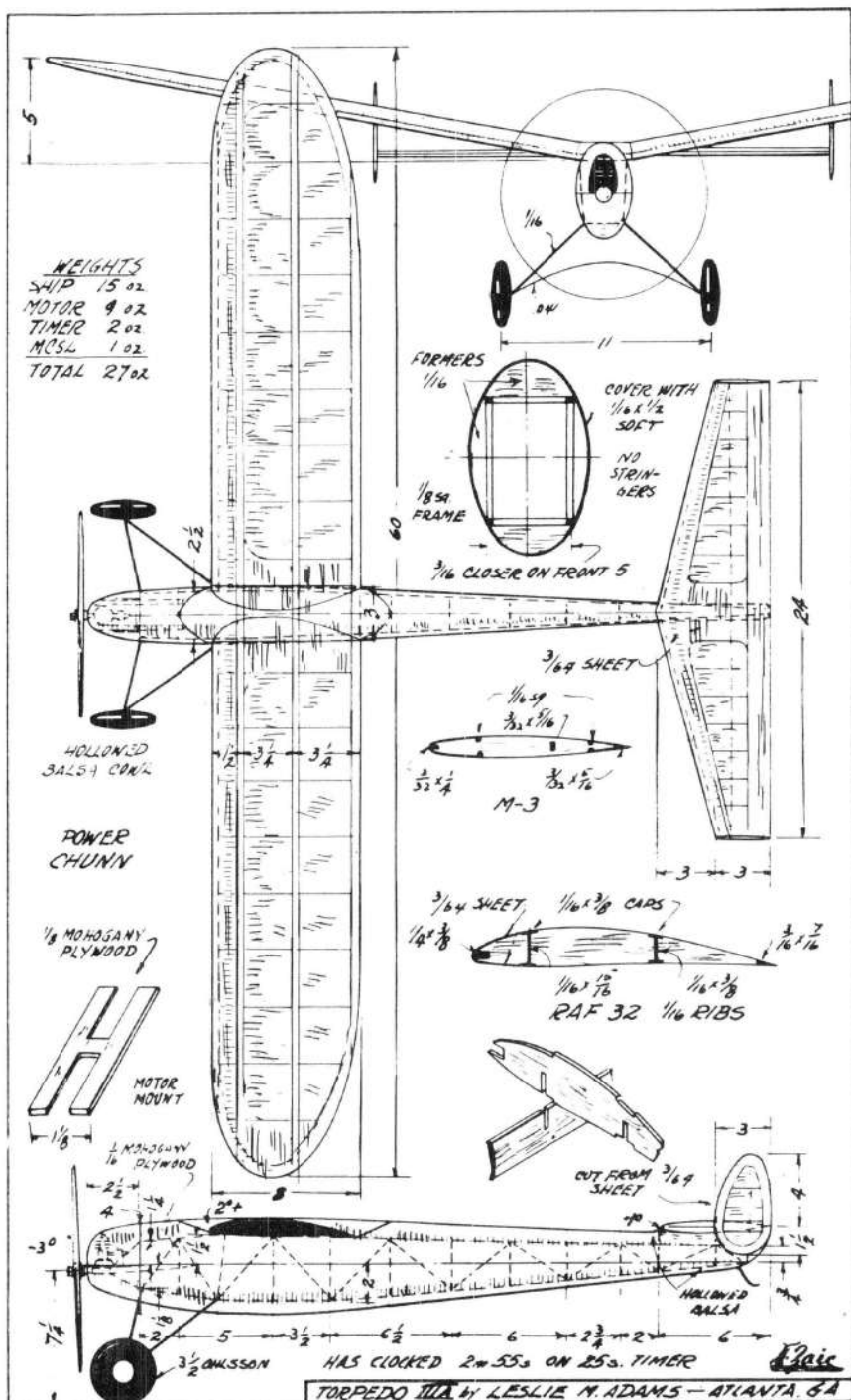


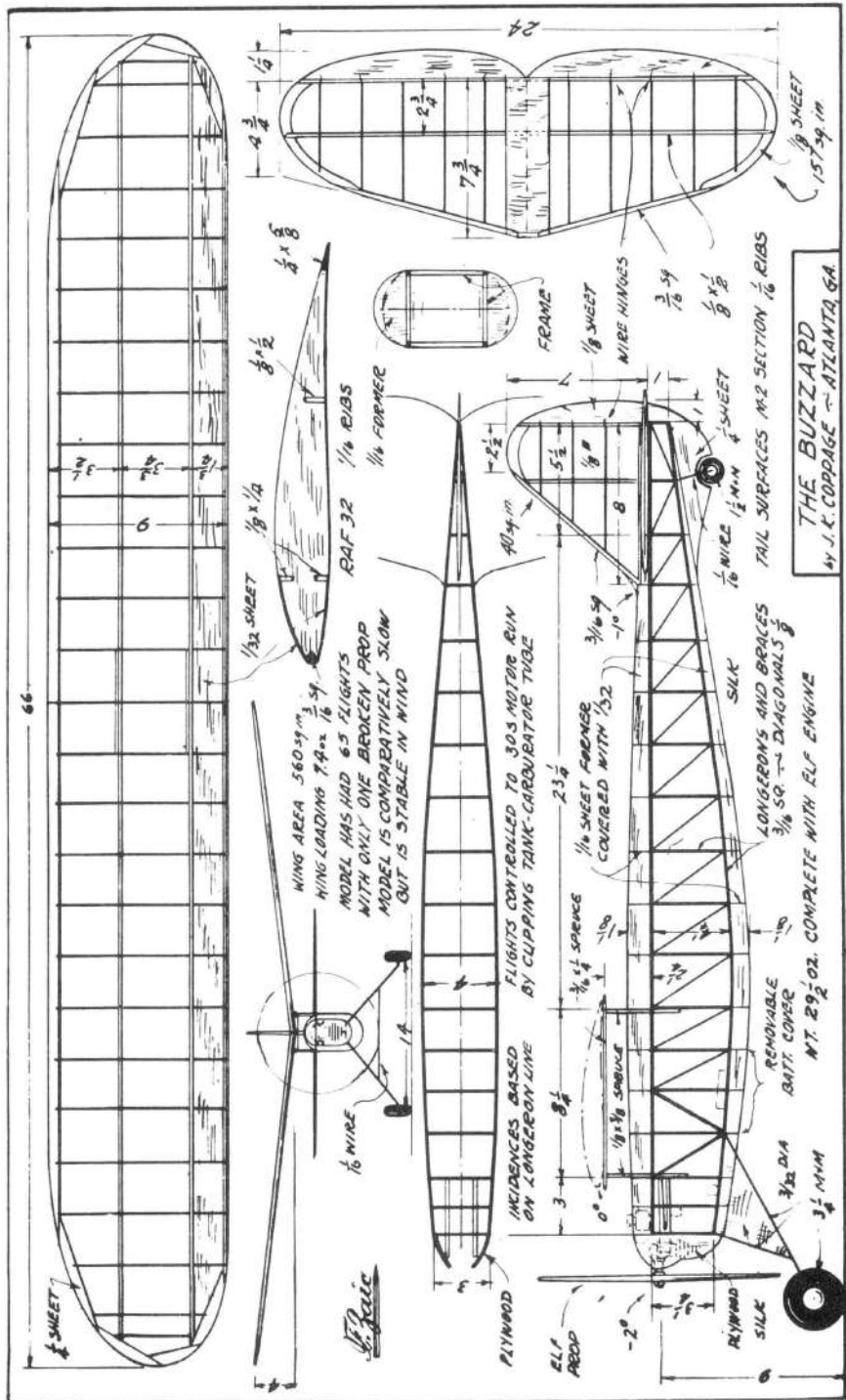


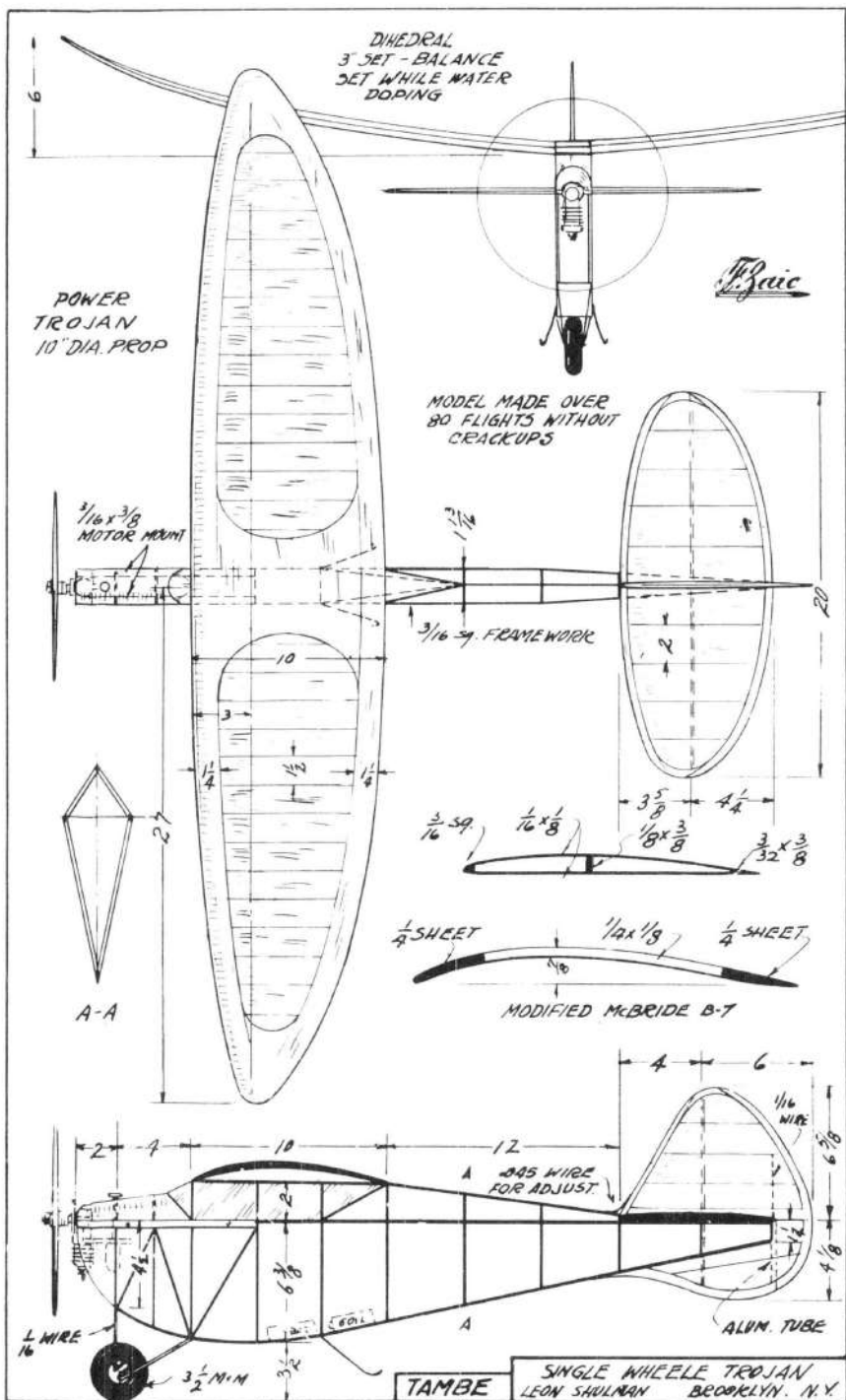


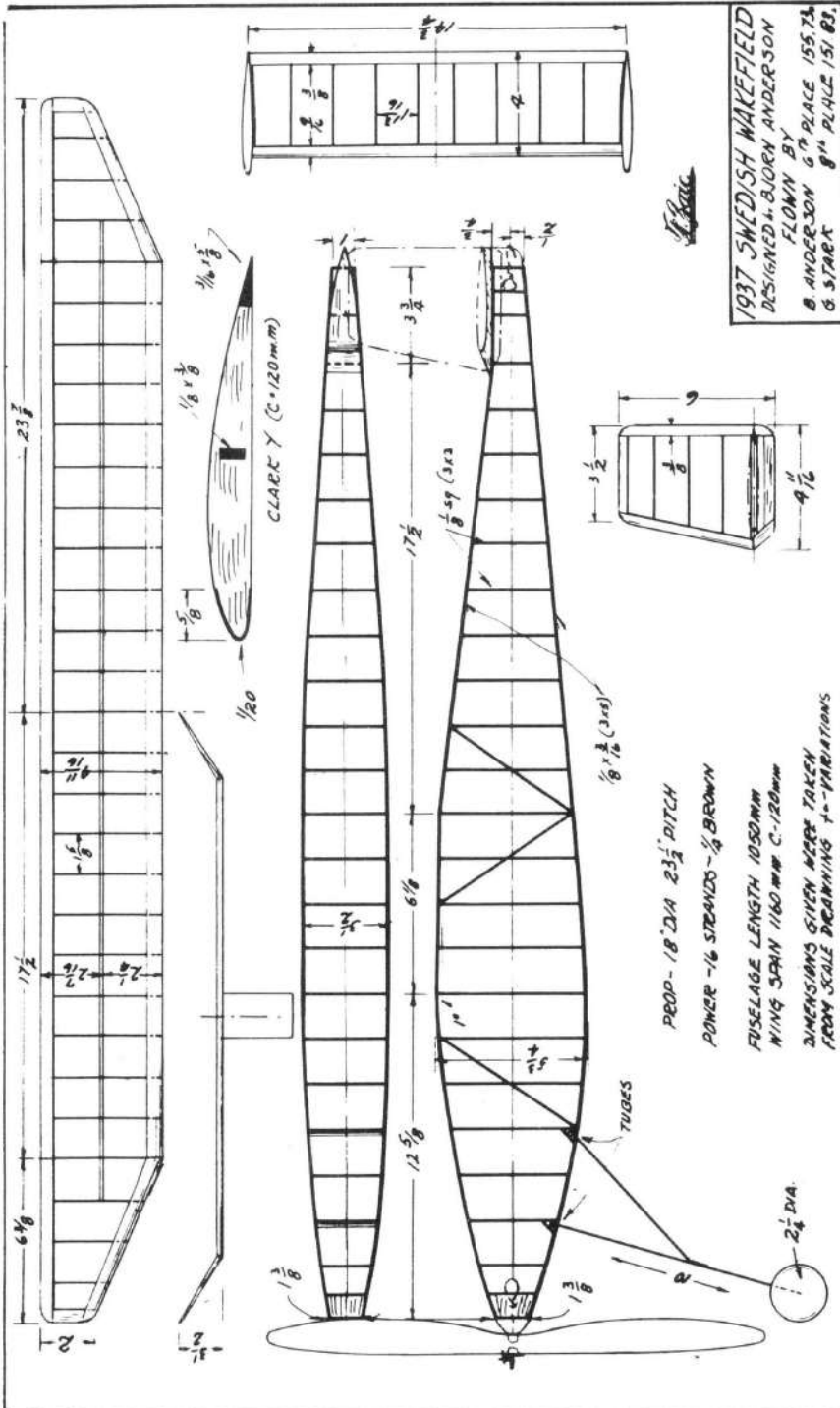












1937 SWEDISH WAKEFIELD
DESIGNED & BUILT BY
B. ANDERSON 6TH PLACE 155.73
O. STARK 8TH PLACE 151.03.

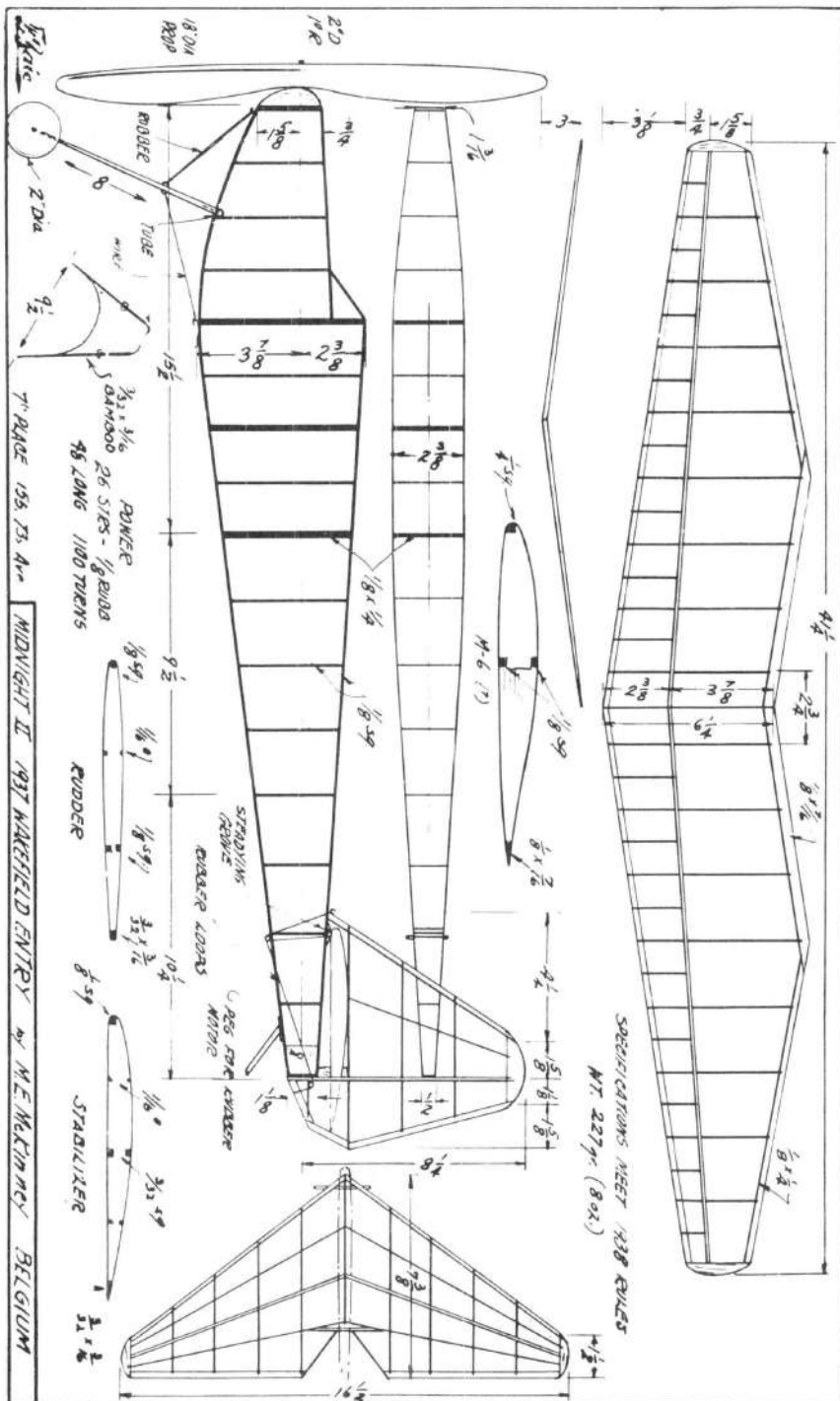
PROP-18°21' 23½" PITCH

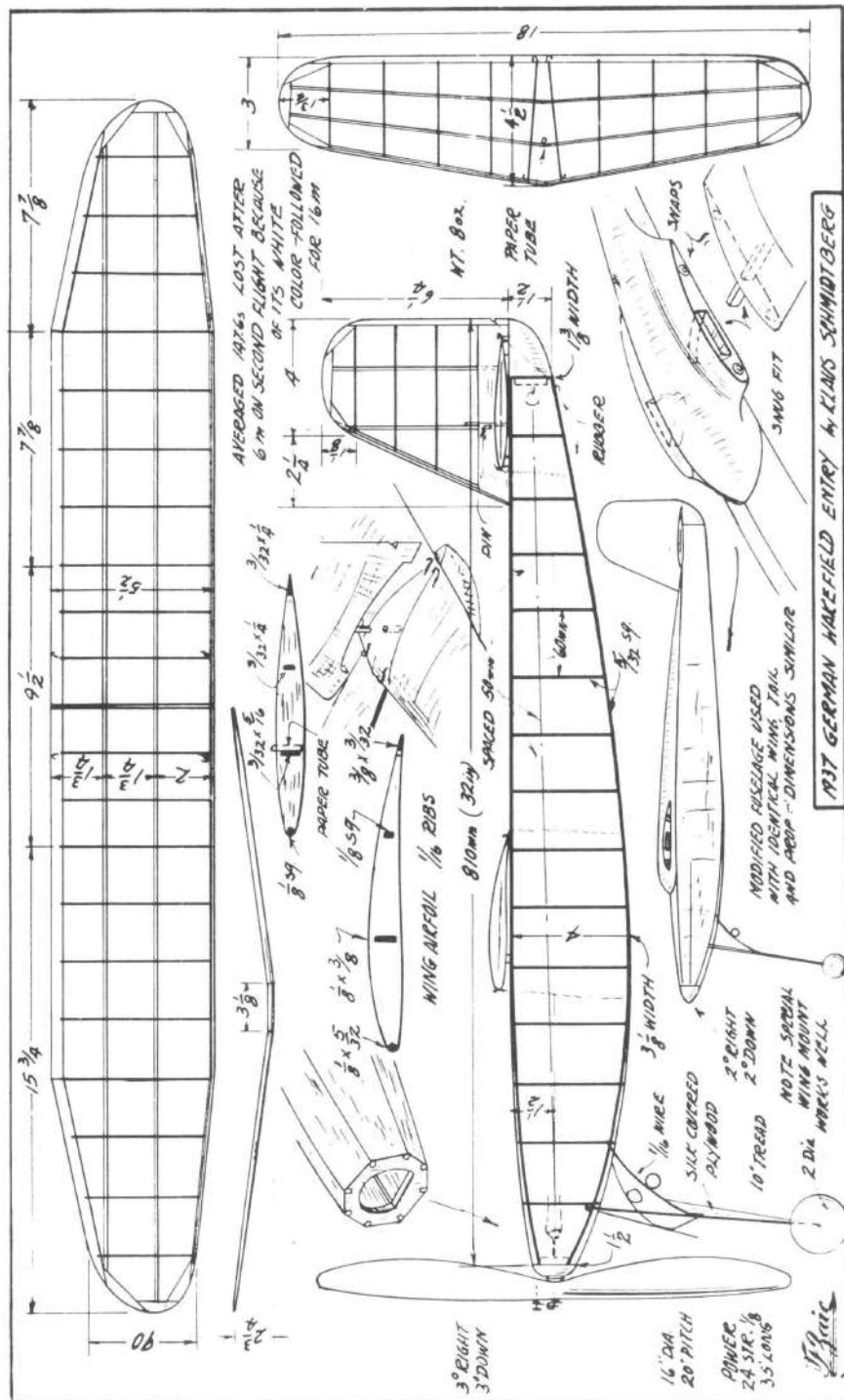
POWER - 1/6 STRANDS - 1/3 BROWN

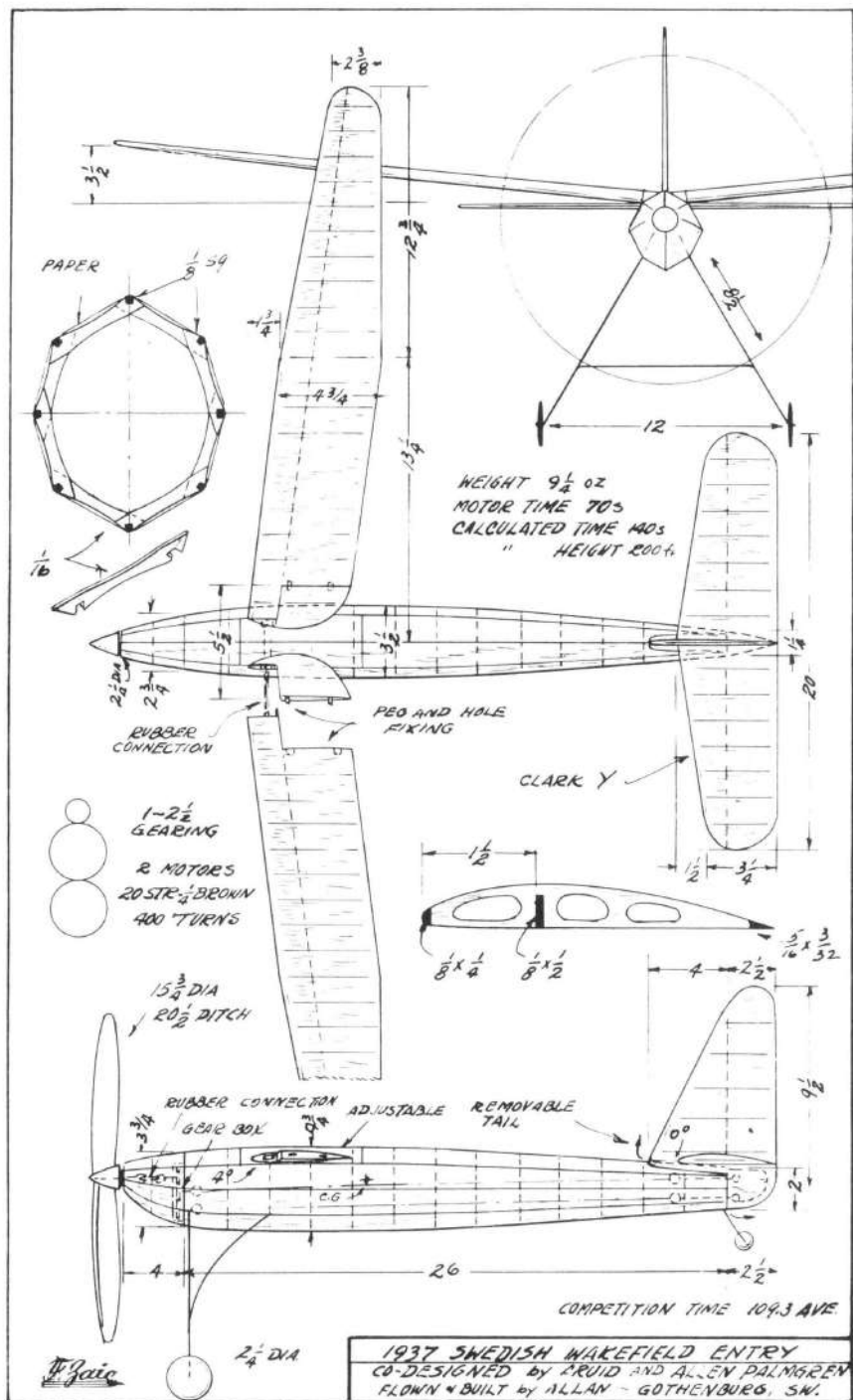
FUSELAGE LENGTH 1050MM

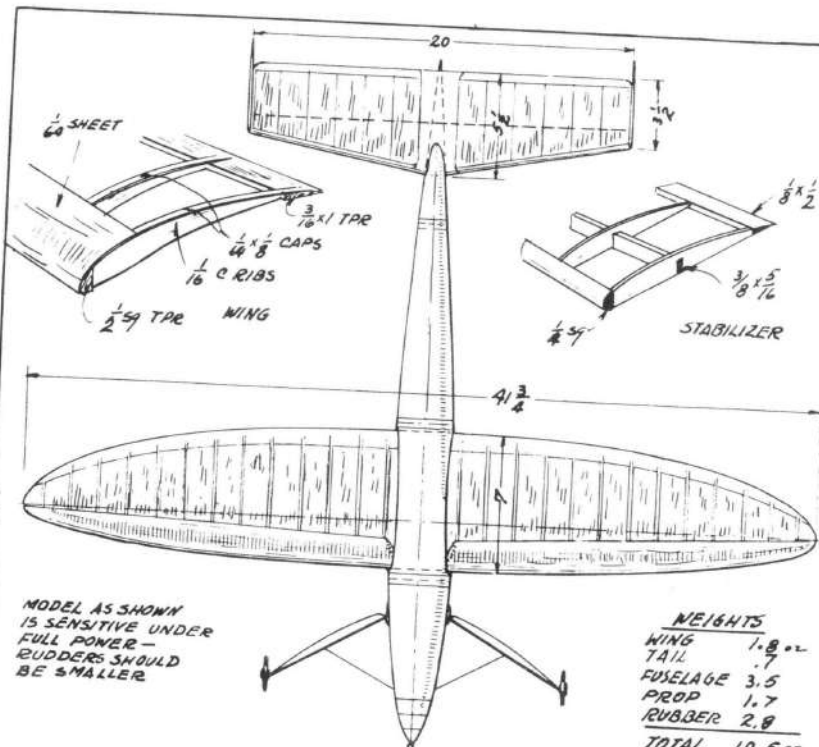
THE UNIVERSITY OF CHICAGO

FROM SCALE DRAWING TO VARIATIONS

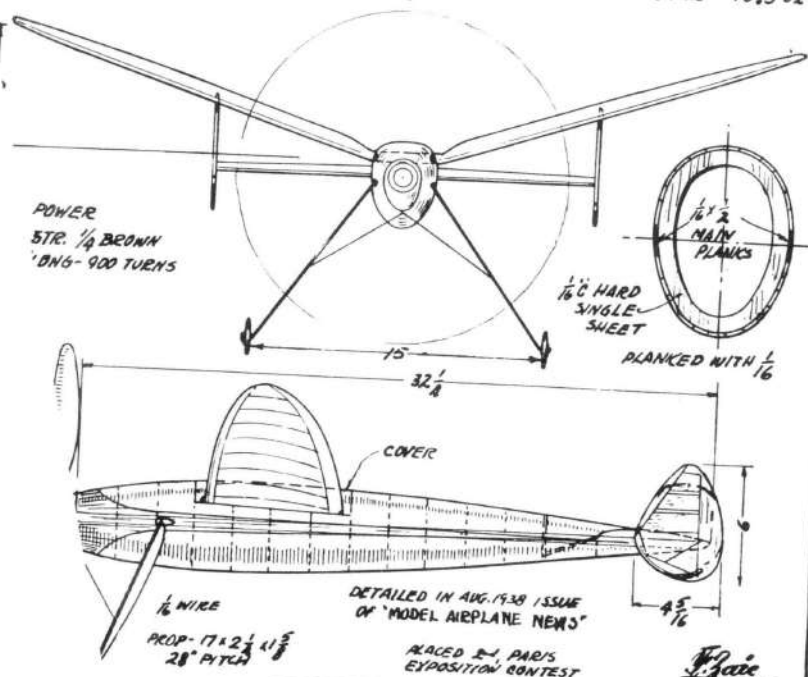




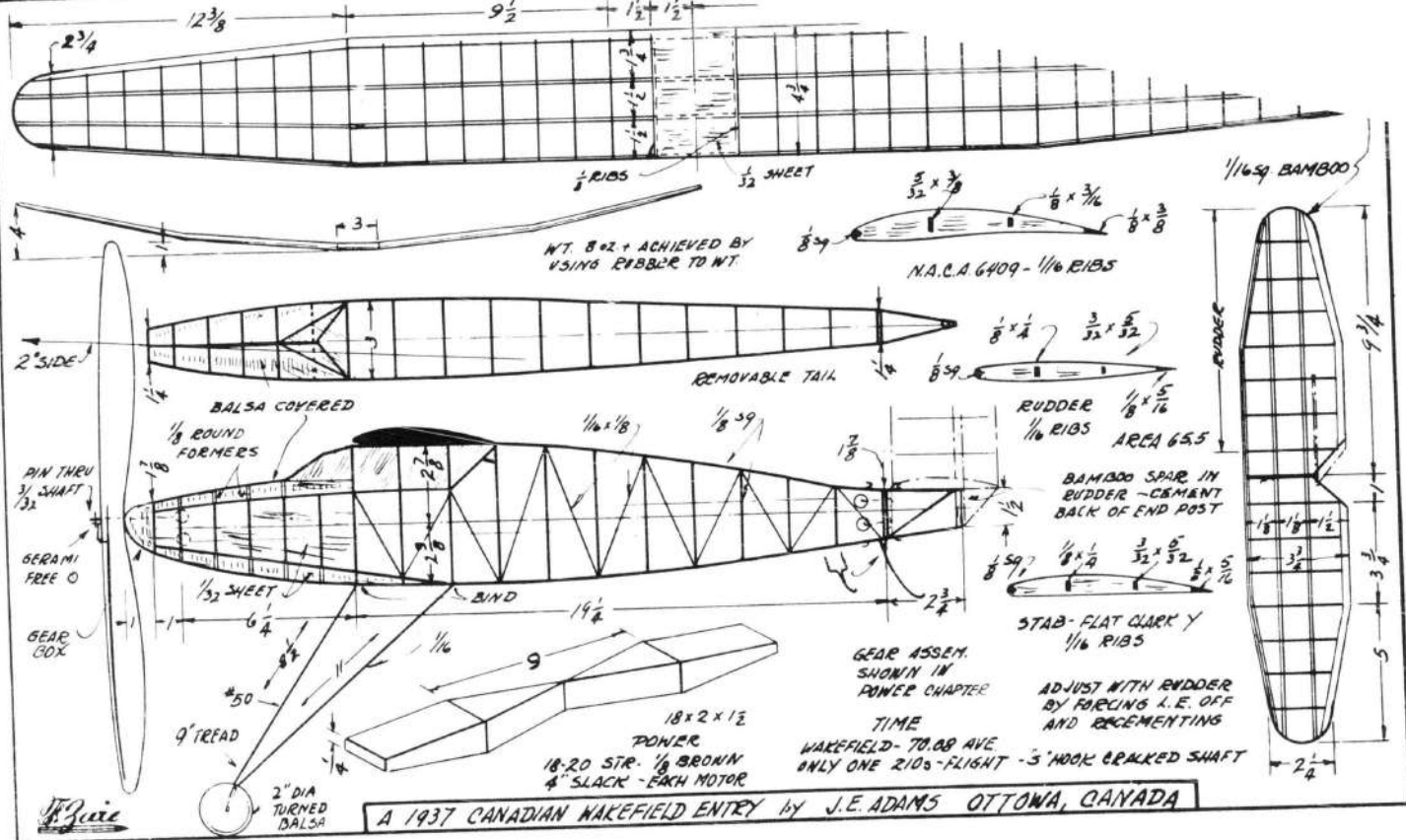


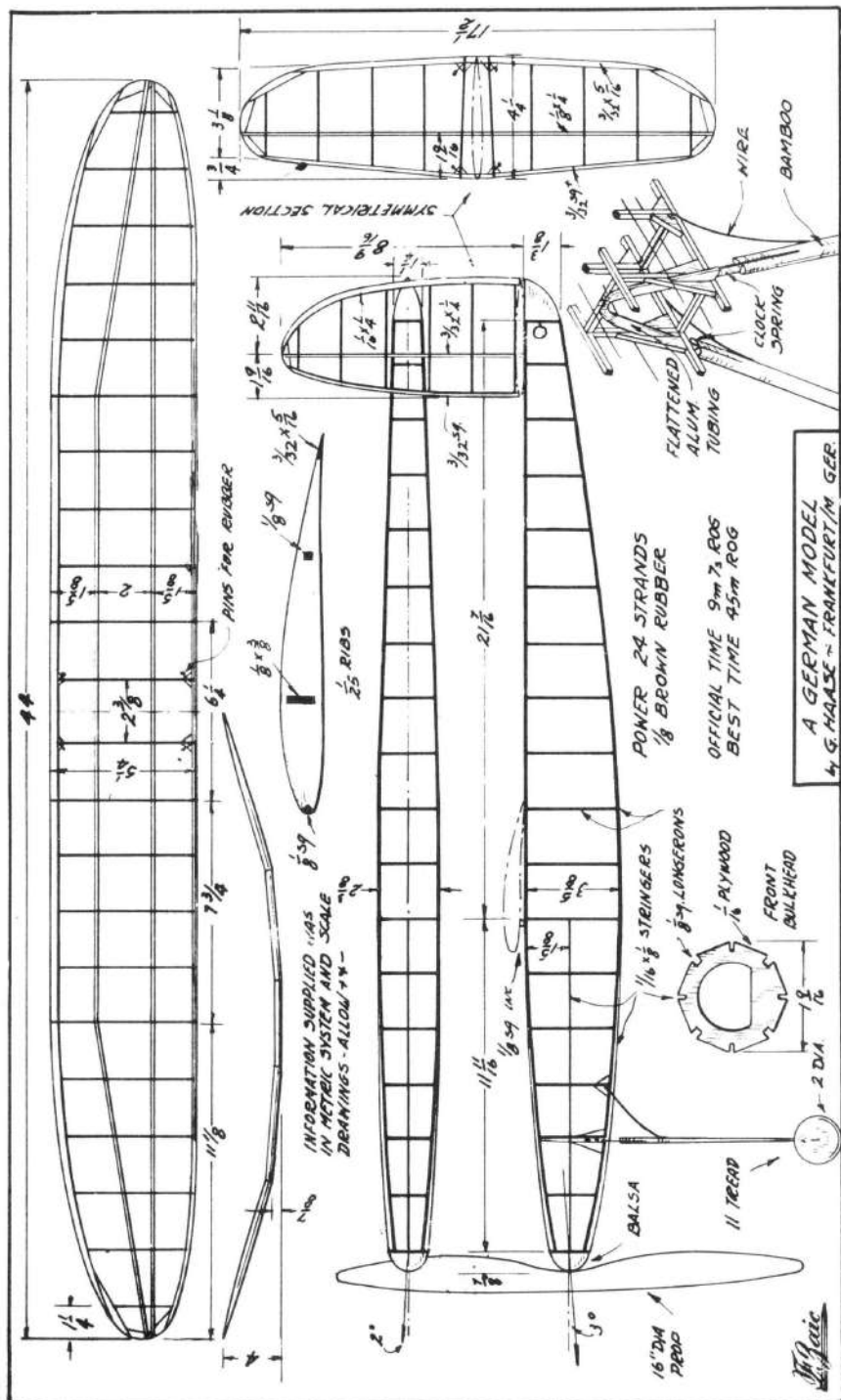


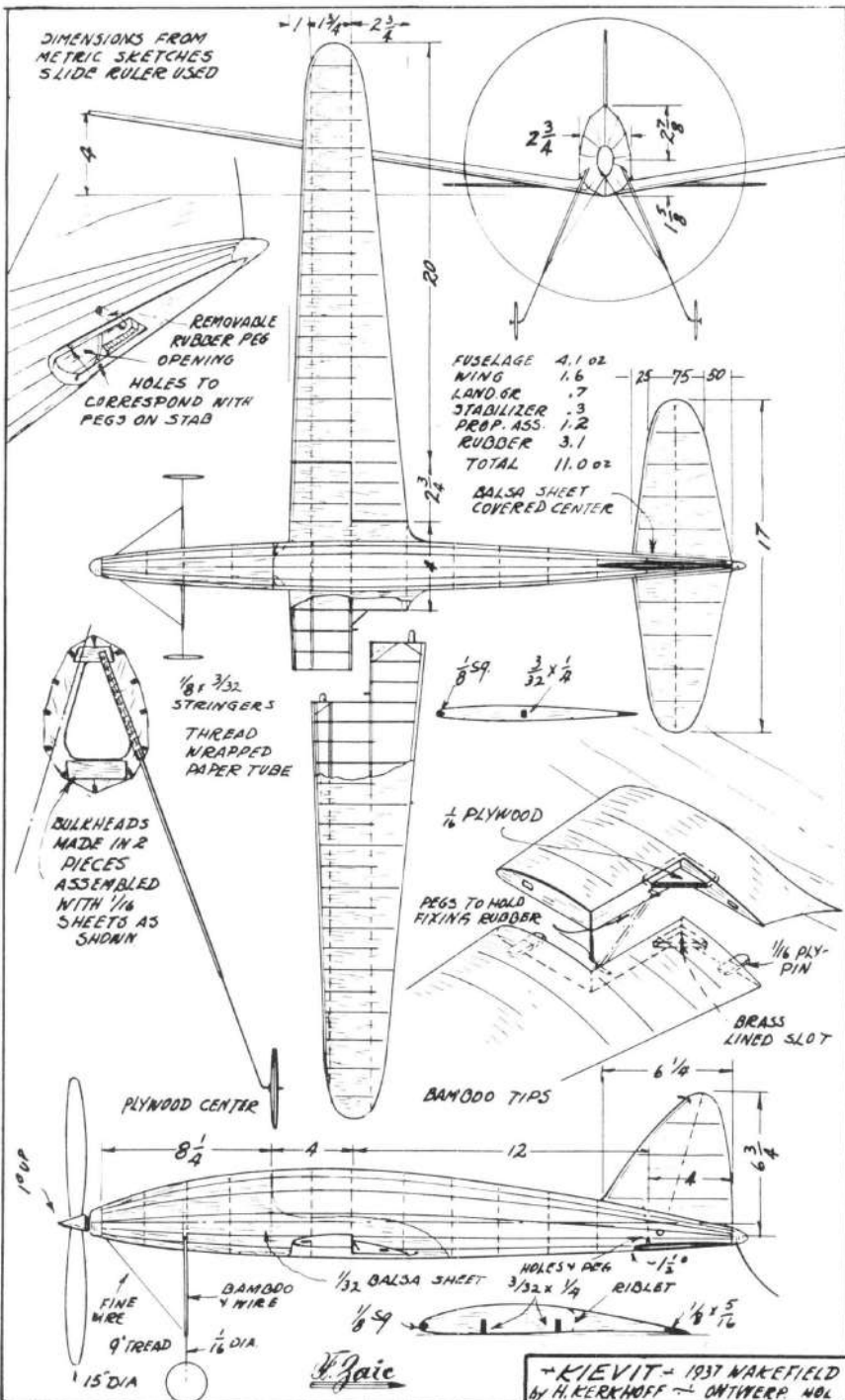
WEIGHTS	
WING	1.8 oz
TAIL	.7
FUSELAGE	3.5
PROP	1.7
RUBBER	2.8
TOTAL	10.5 oz

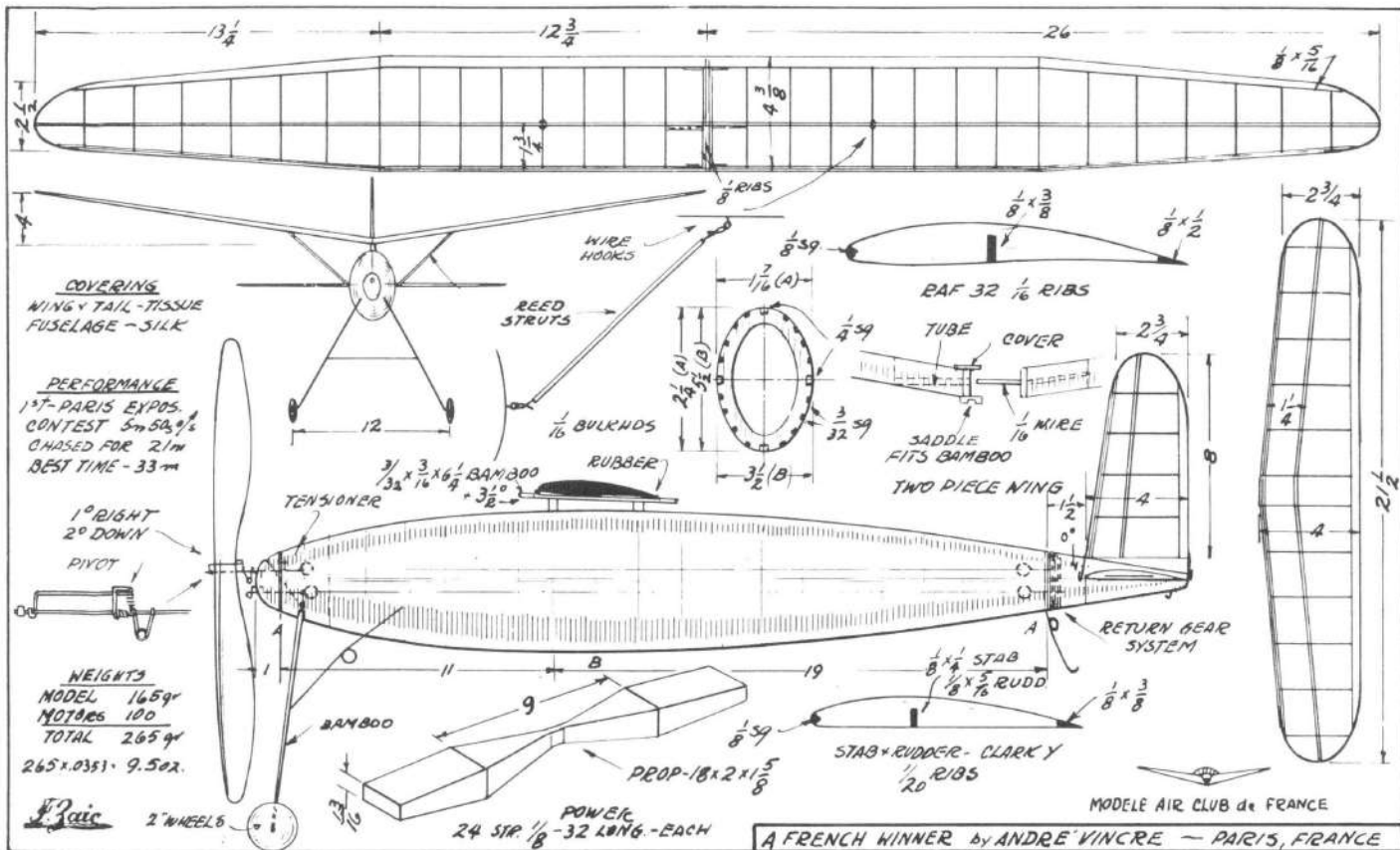


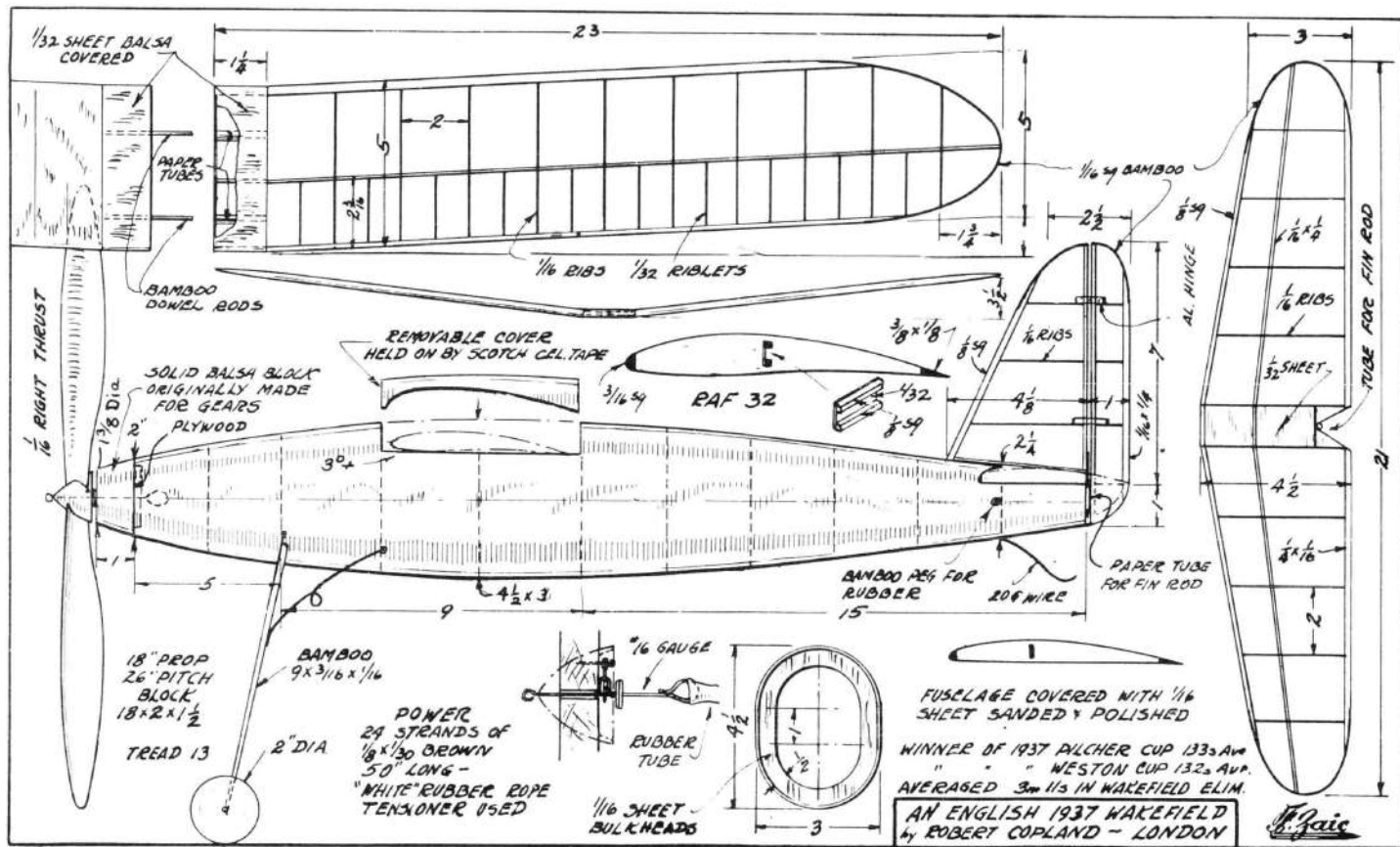
1937 WAKEFIELD ENTRY BY FRANK ZALC - NEW YORK N.Y.

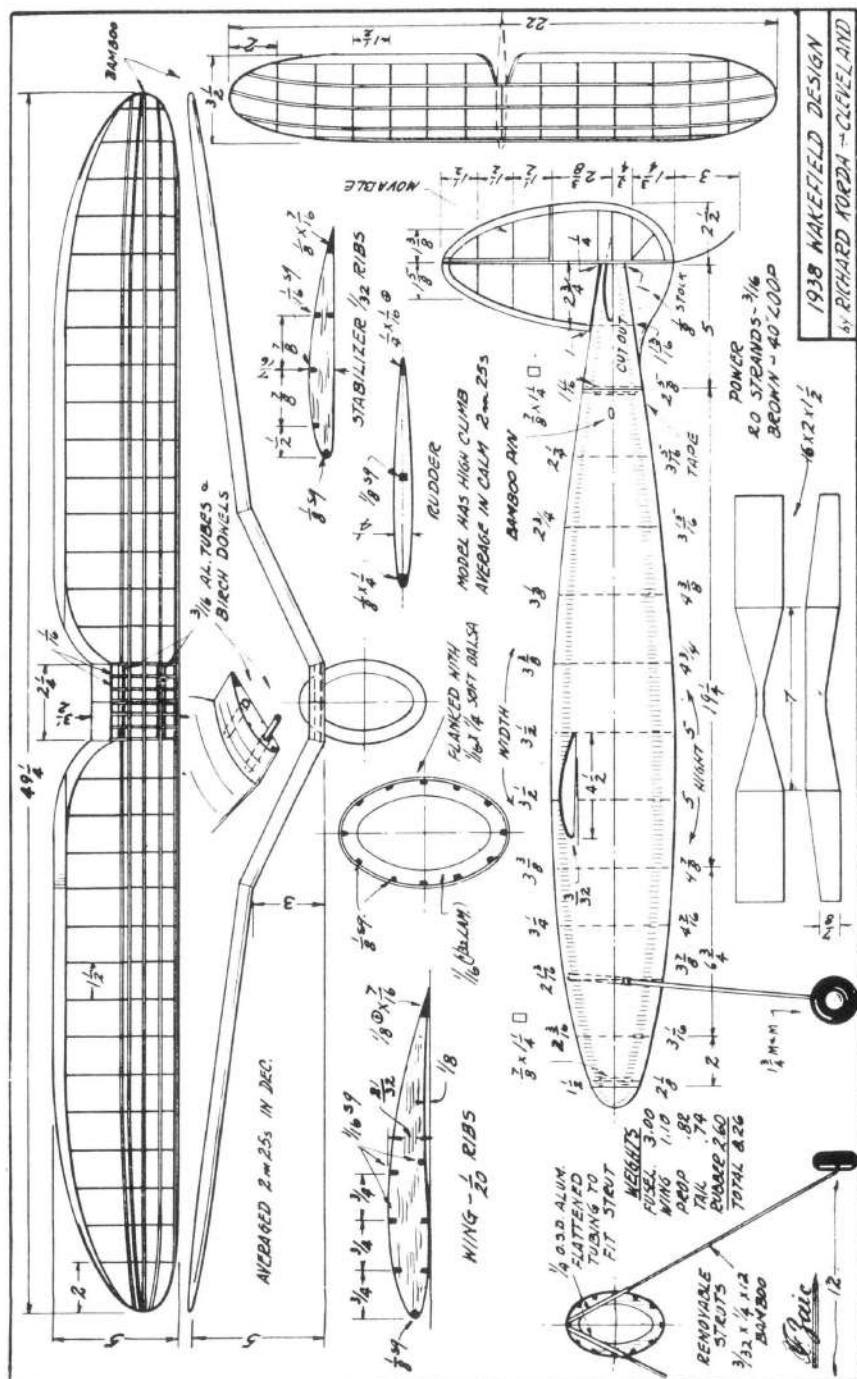


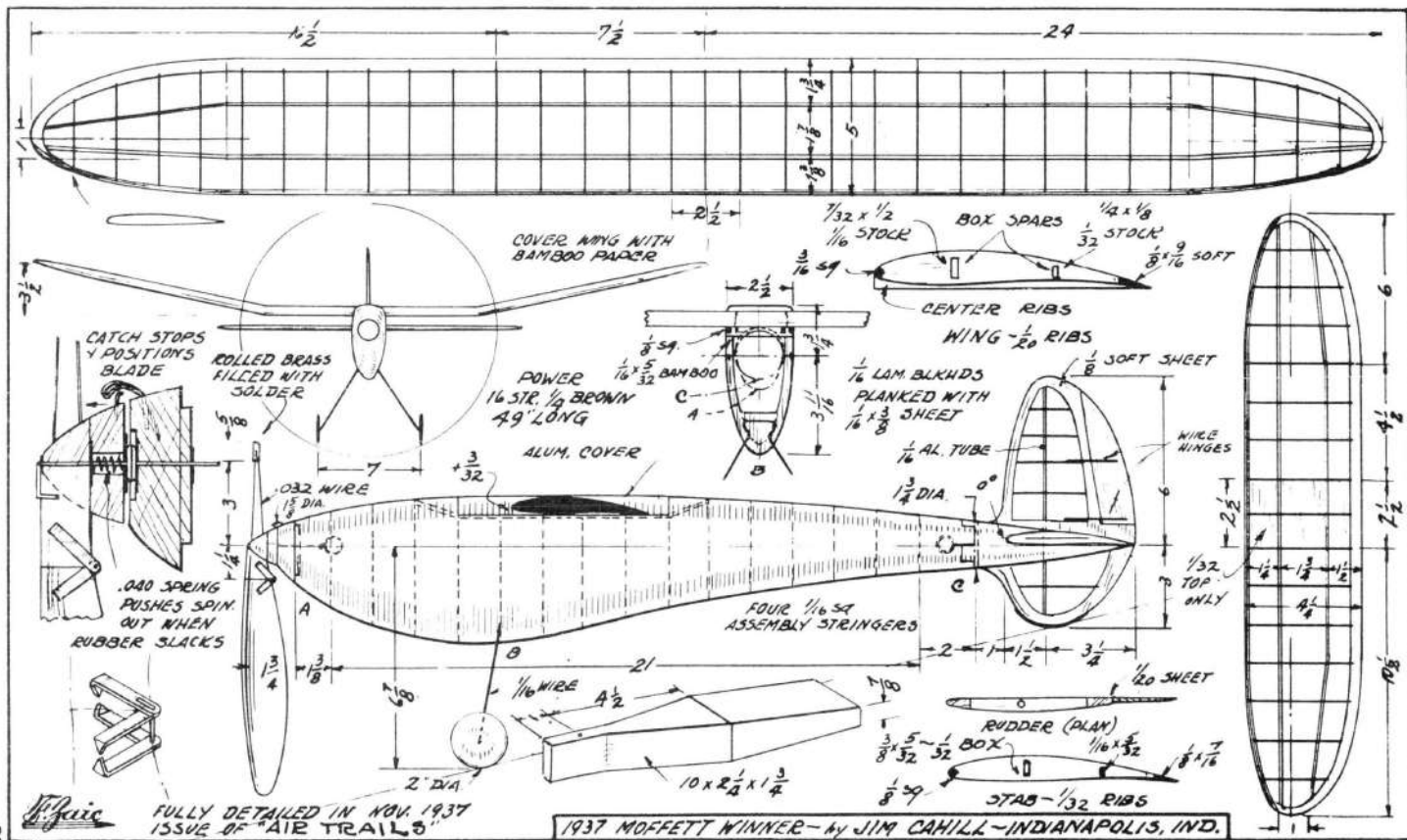


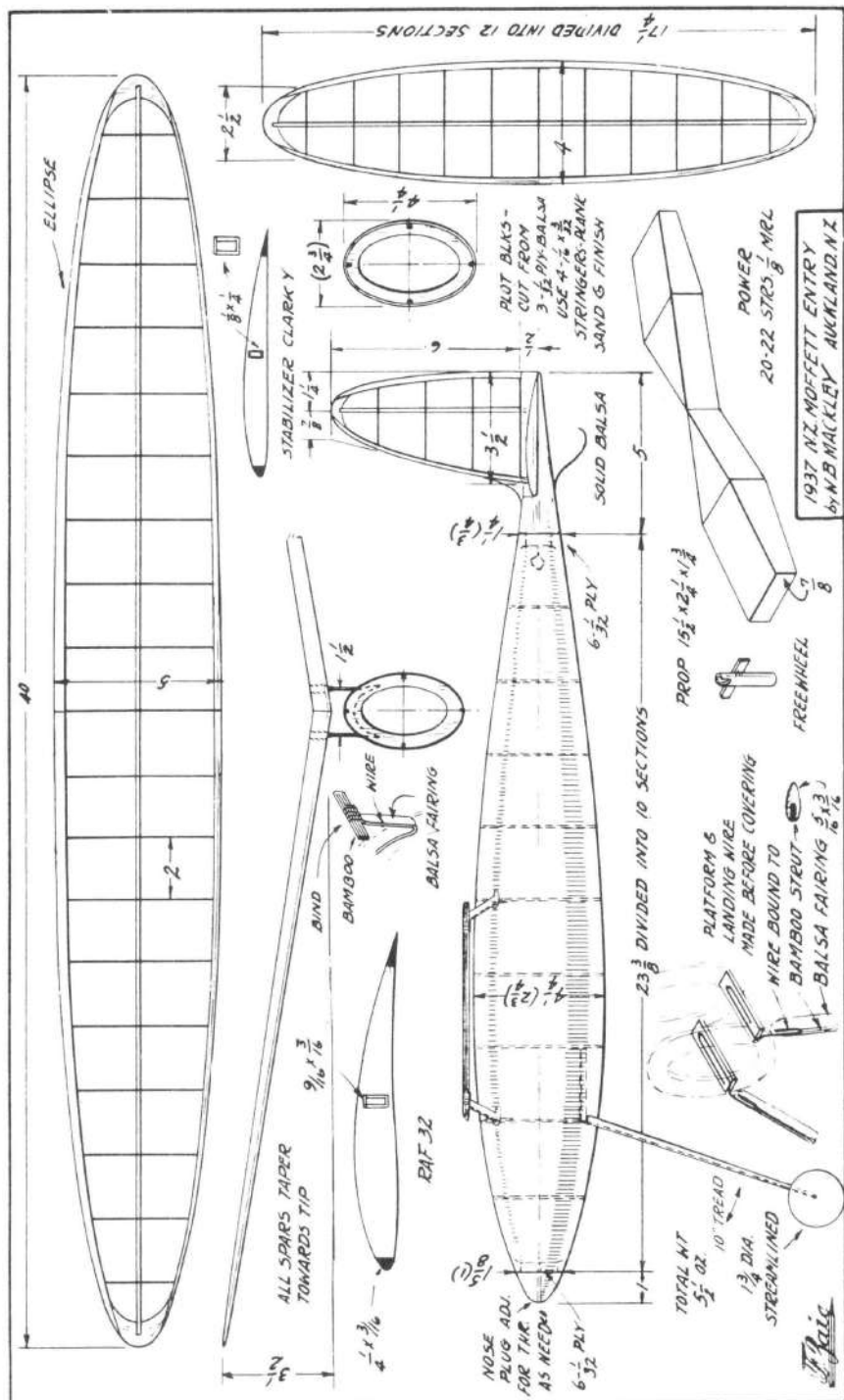


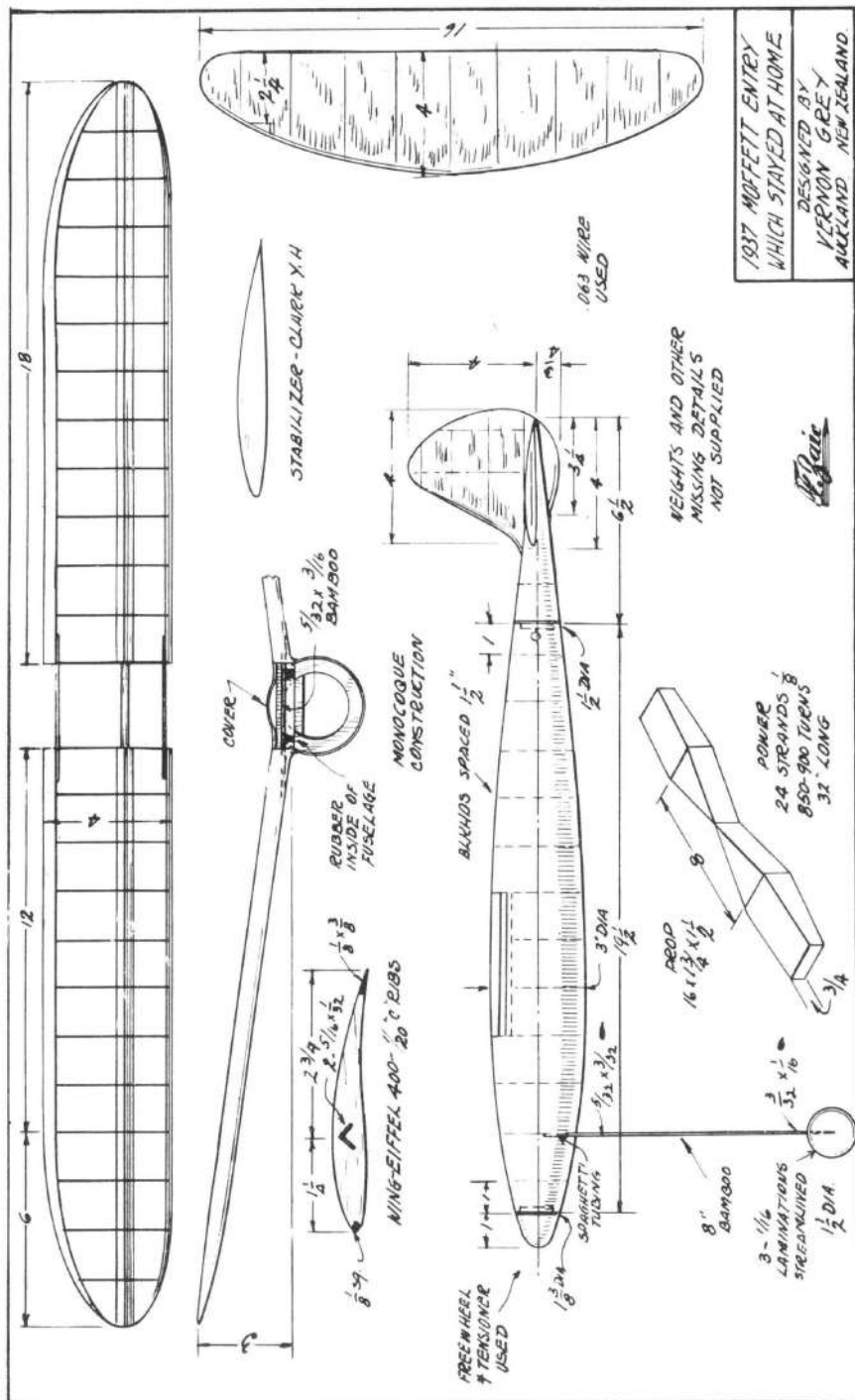


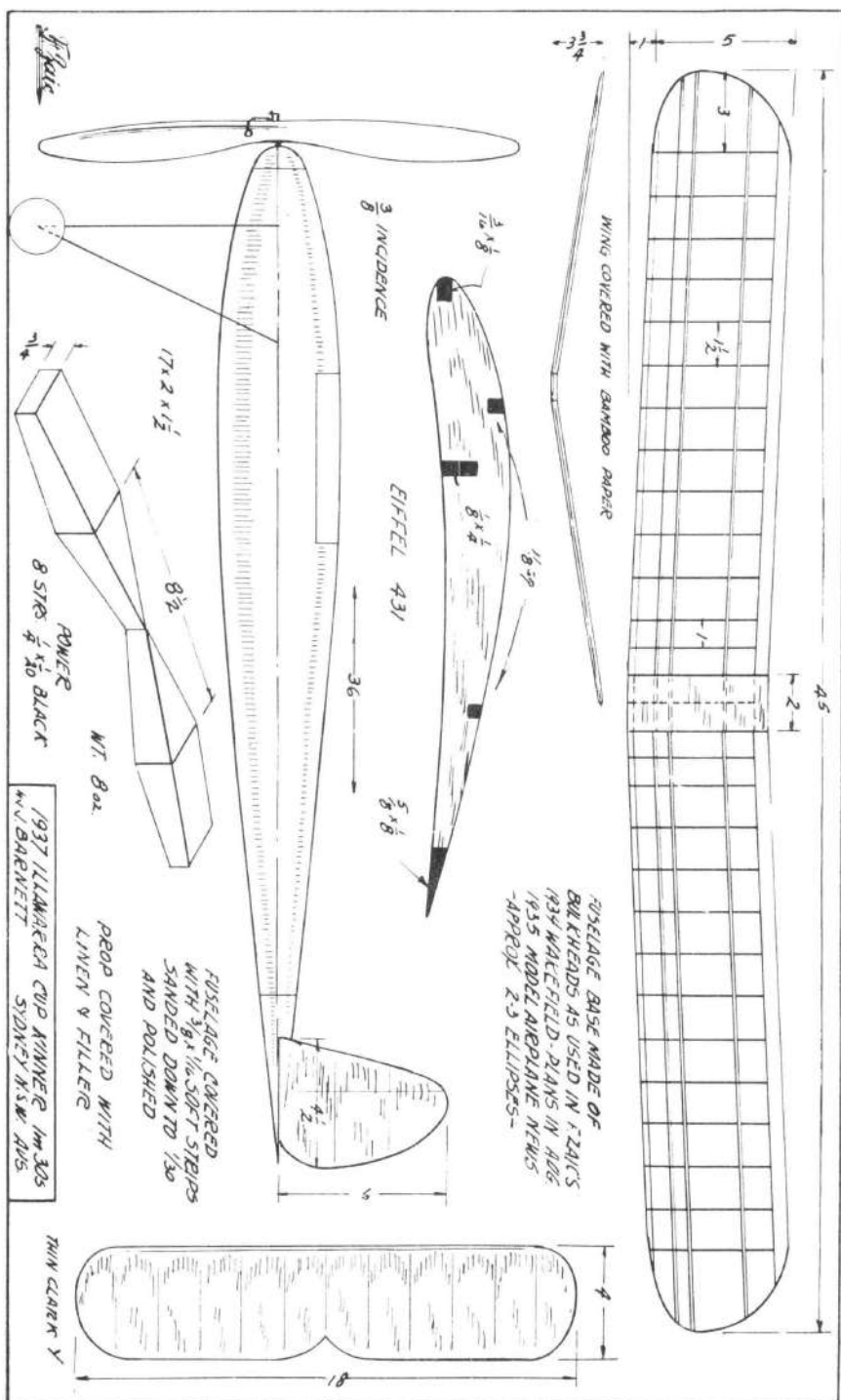


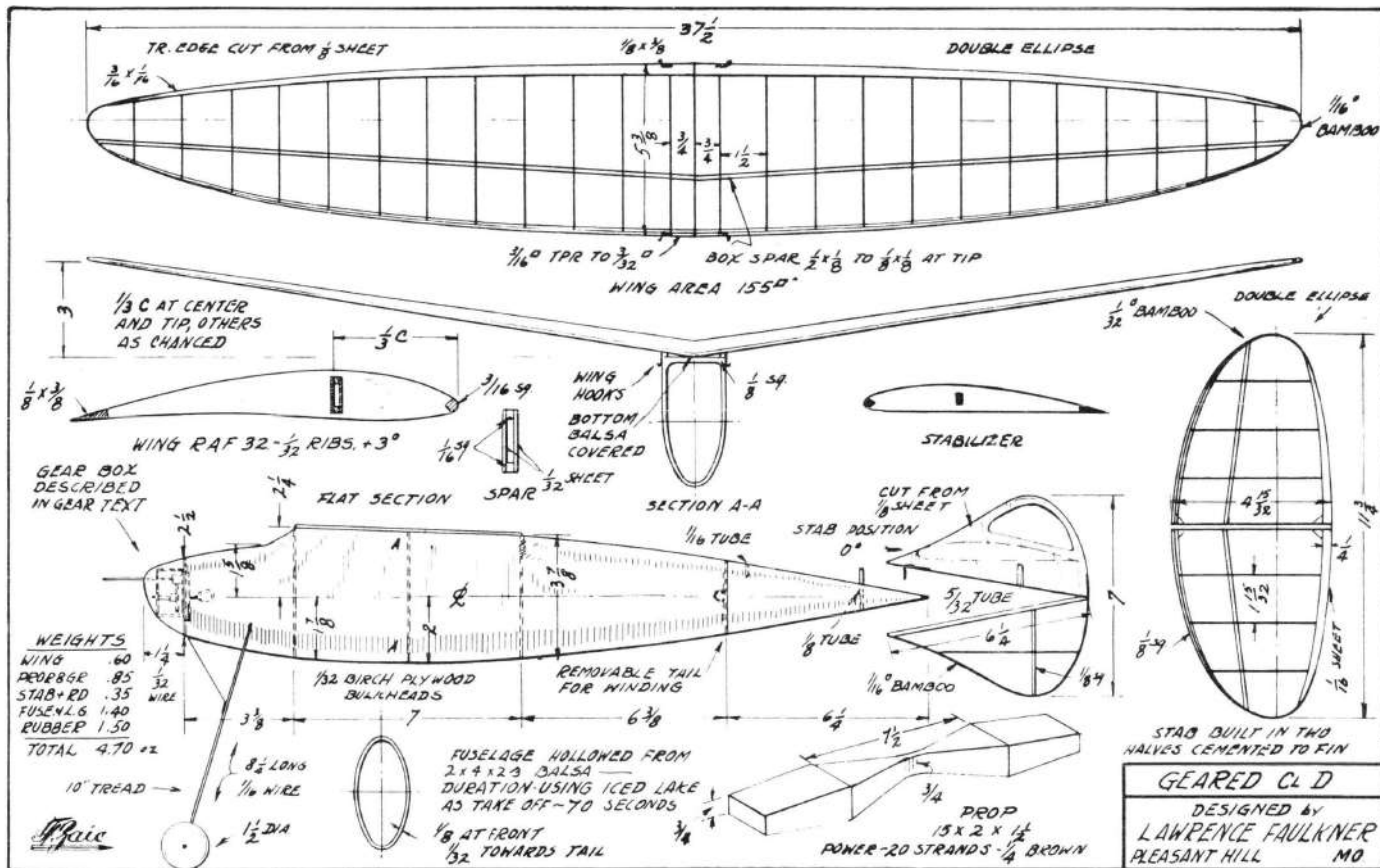


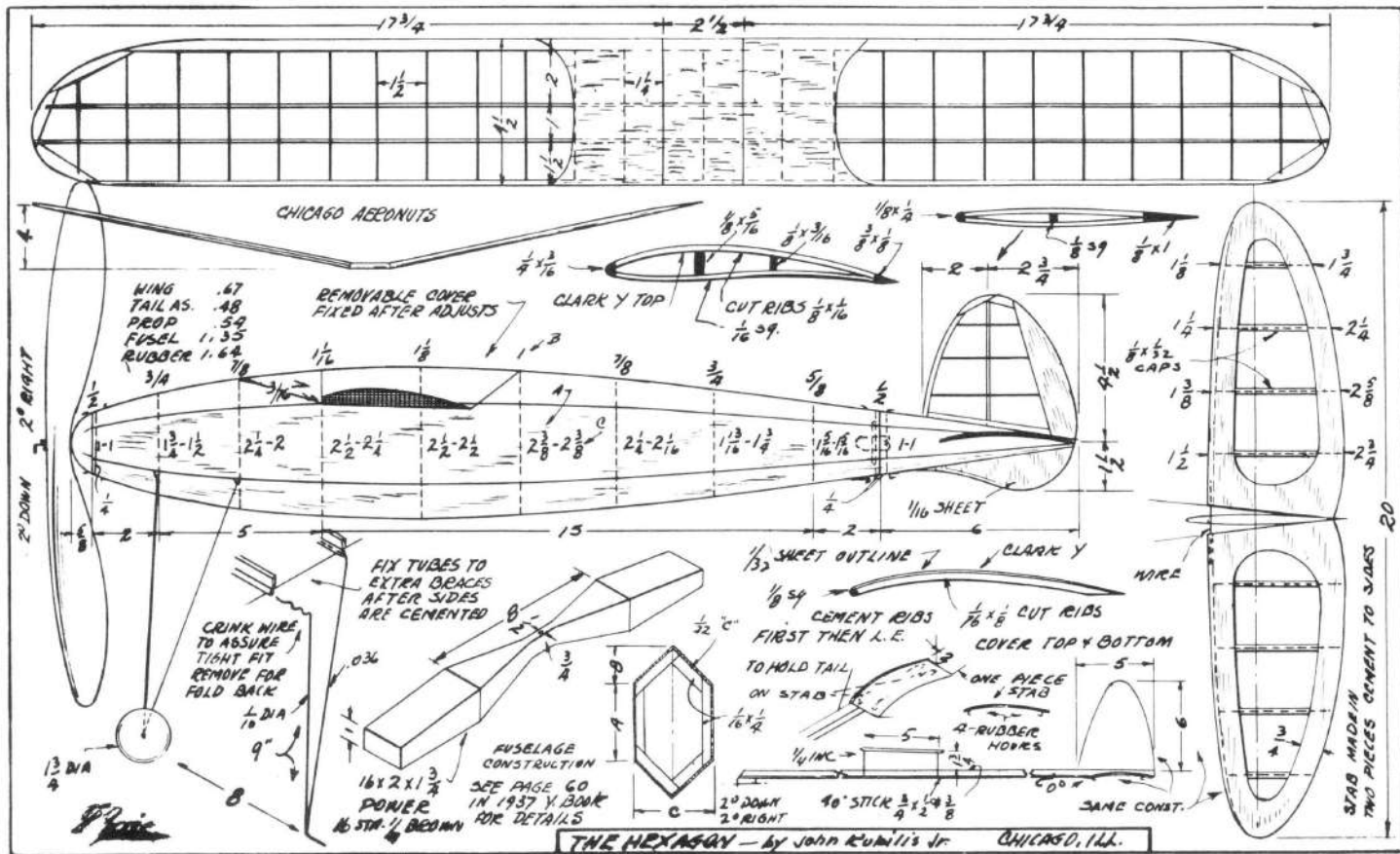


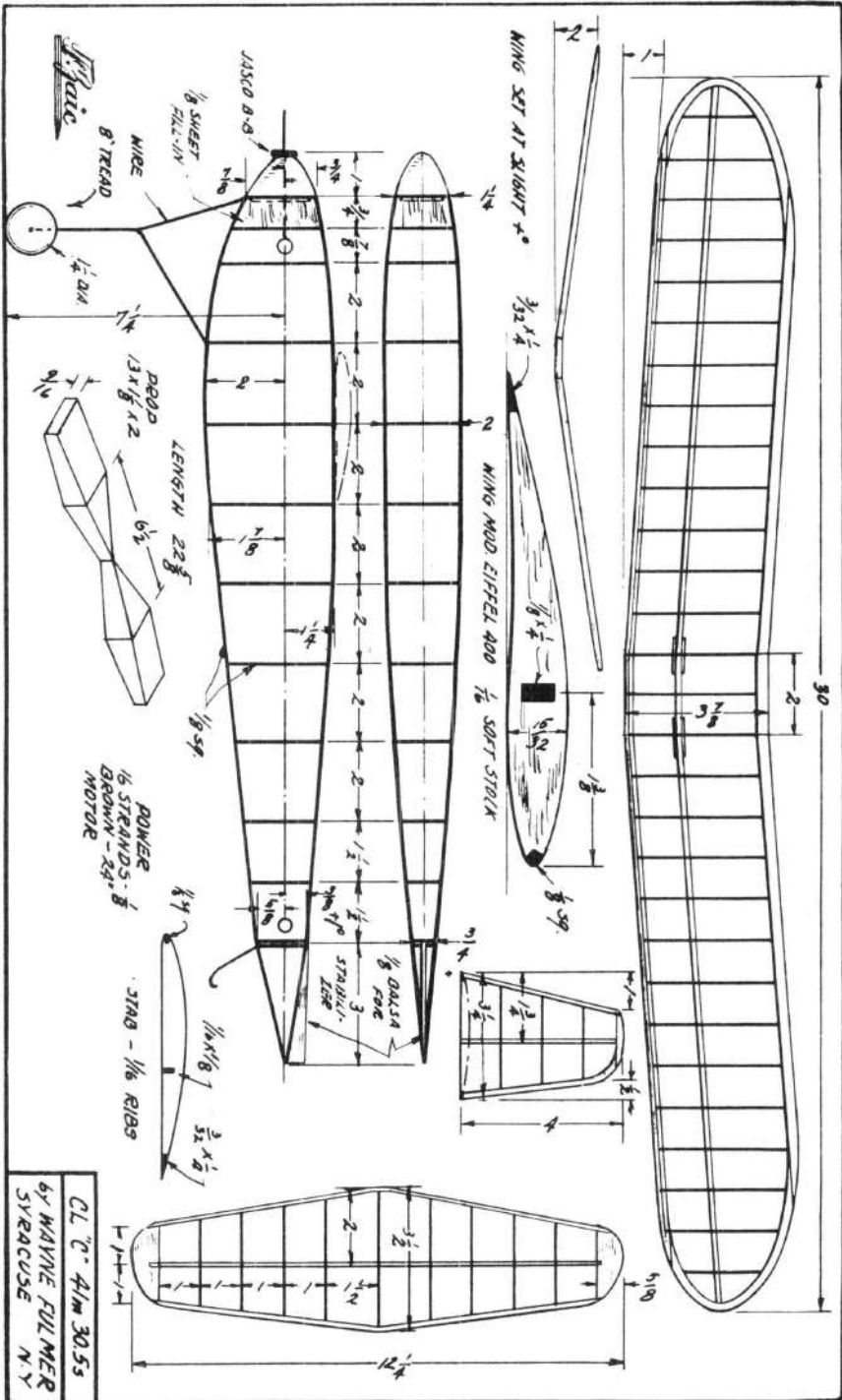




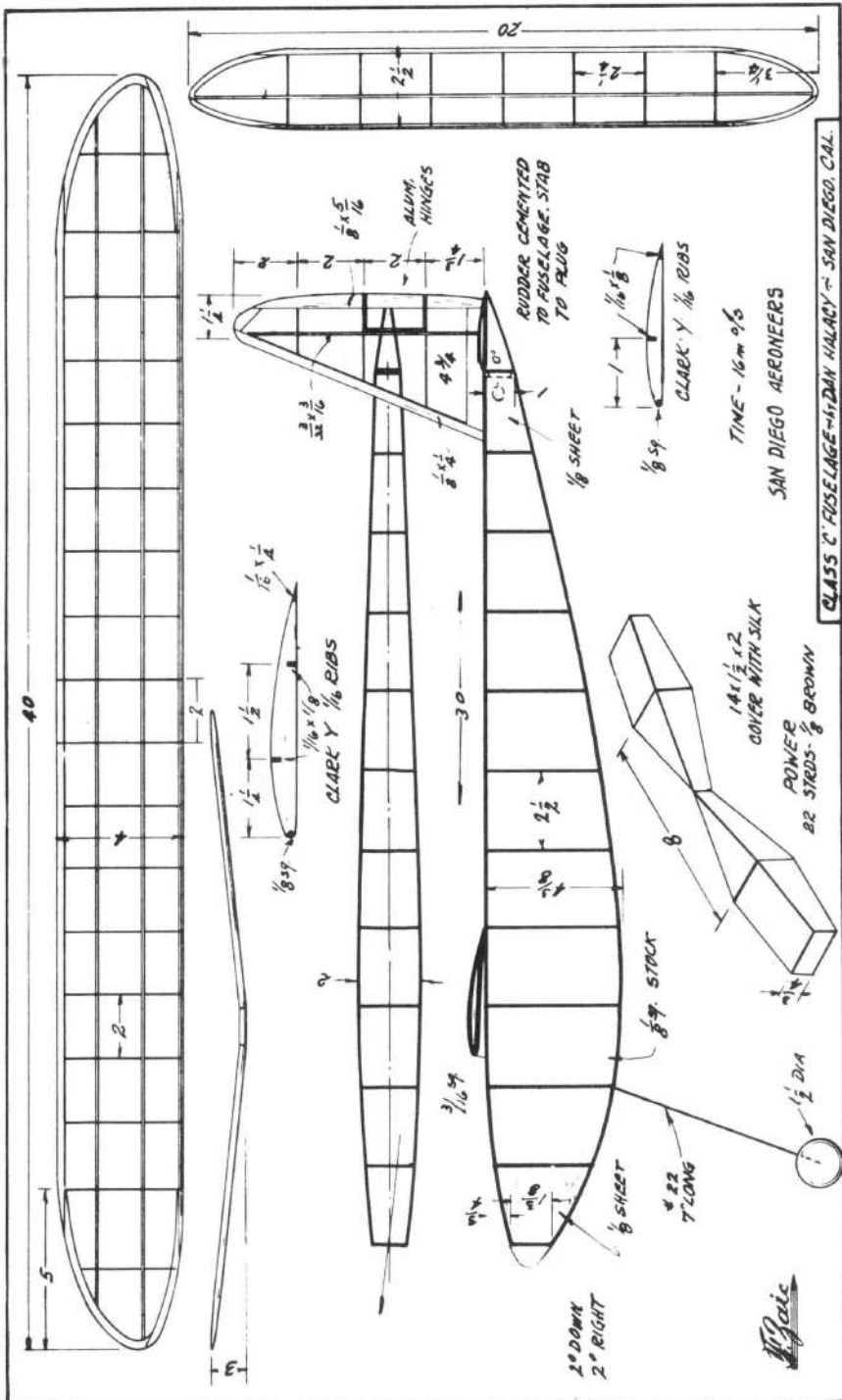


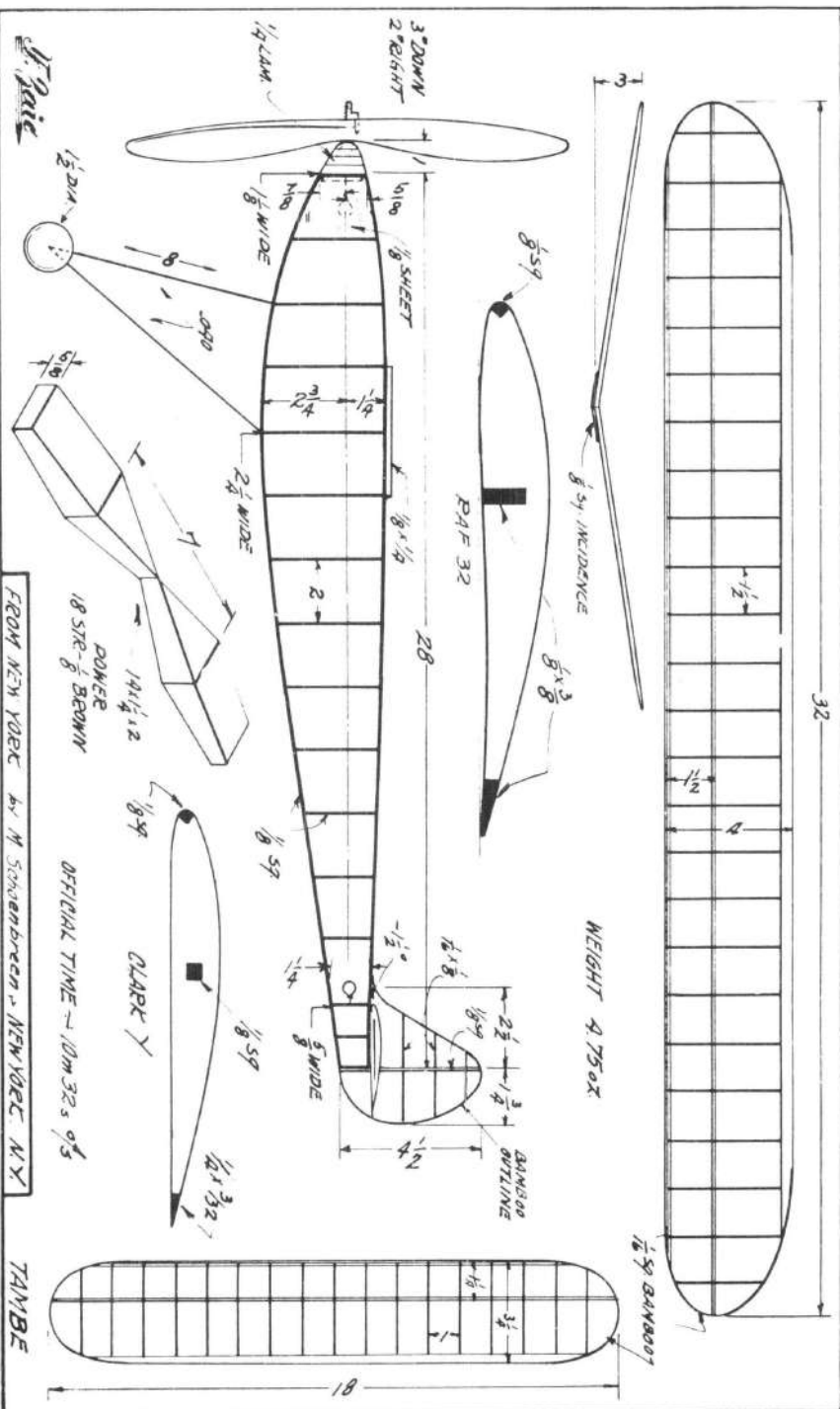


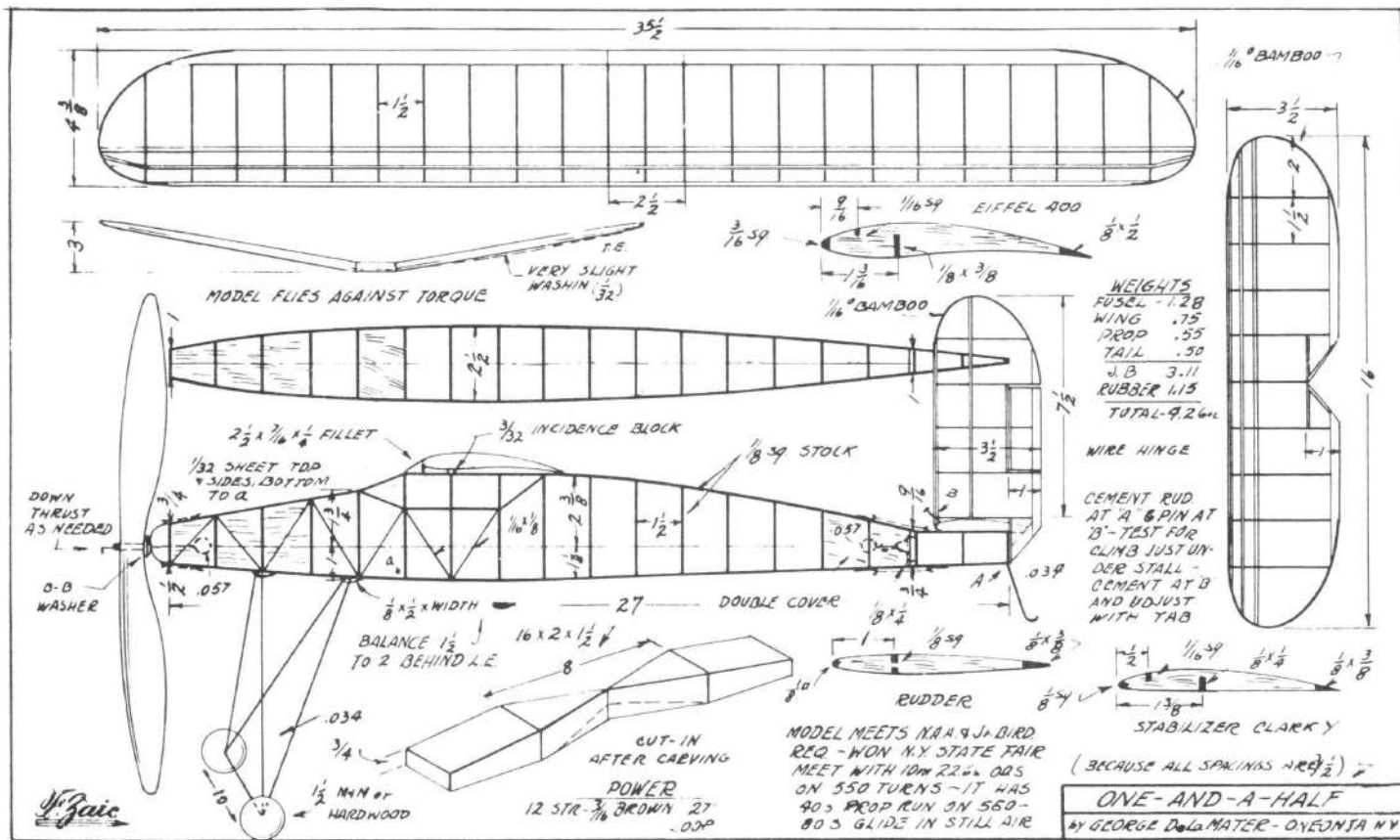


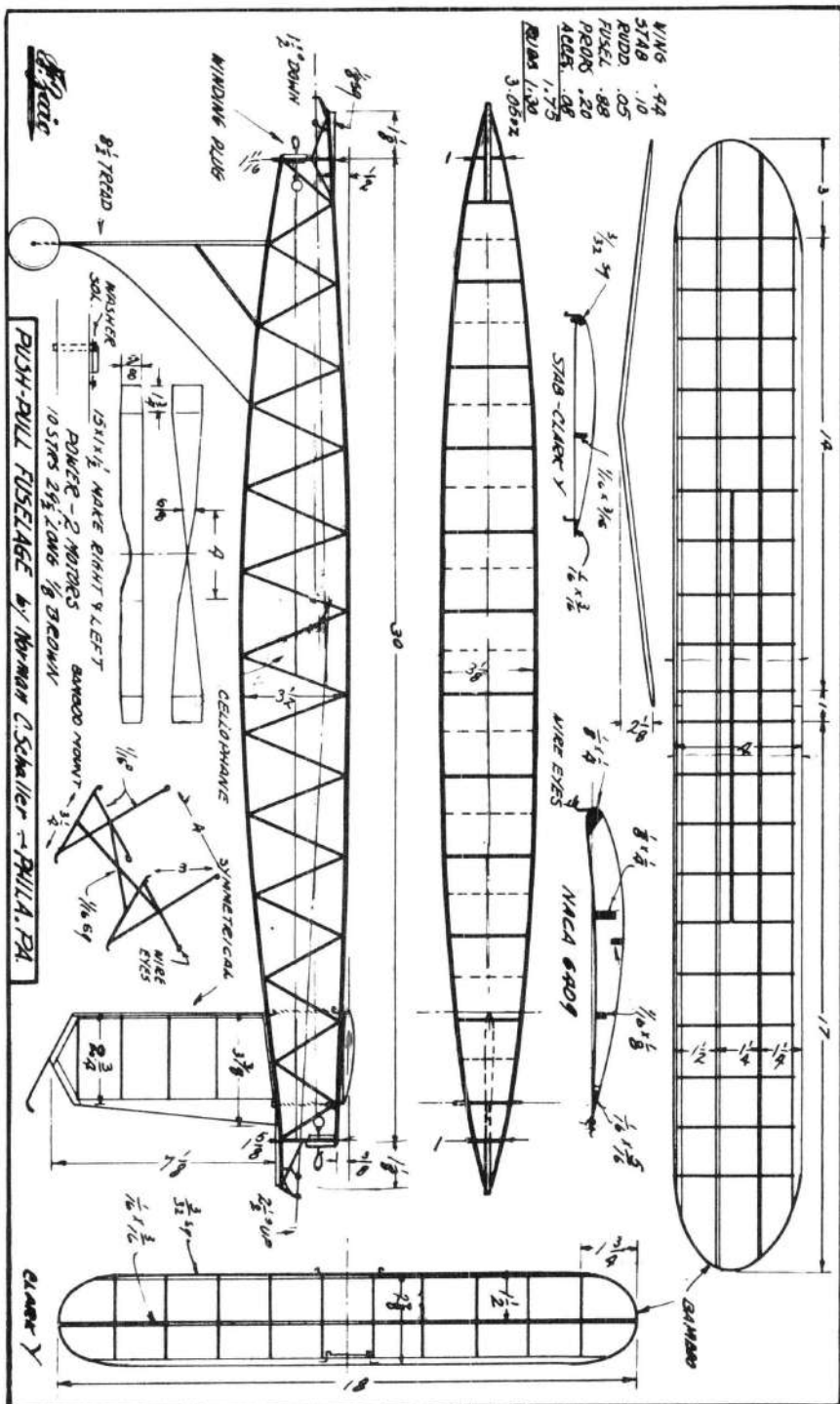


CL "C" 41m 30.55
by WAYNE FULLMER
SYRACUSE N.Y









TIME
1m 30s TO WIN
AT STATE FAIR

H. Zaic

THREAD BRACES

**BOLD LINES
SHOW CONTROL
SURFACES
MARKED WITH
1/16 BLACK PAPER
STRIPS**

JASCO FREE @
w B.B. WASHER

COWLING CARVED
TO 1/8 WALLS
BUT LONGERONS
AND CROSS
BRACES FOR
SMOOTH FIT

PINE PROP
10' x 1 3/4" x 7/8"

POWER
32 LOOP 10 STR 3/16 IN.
RUBBER TENSIONER
SEE PAGE

USE #22 WIRE

HEAVY LINES =
BASIC FRAME

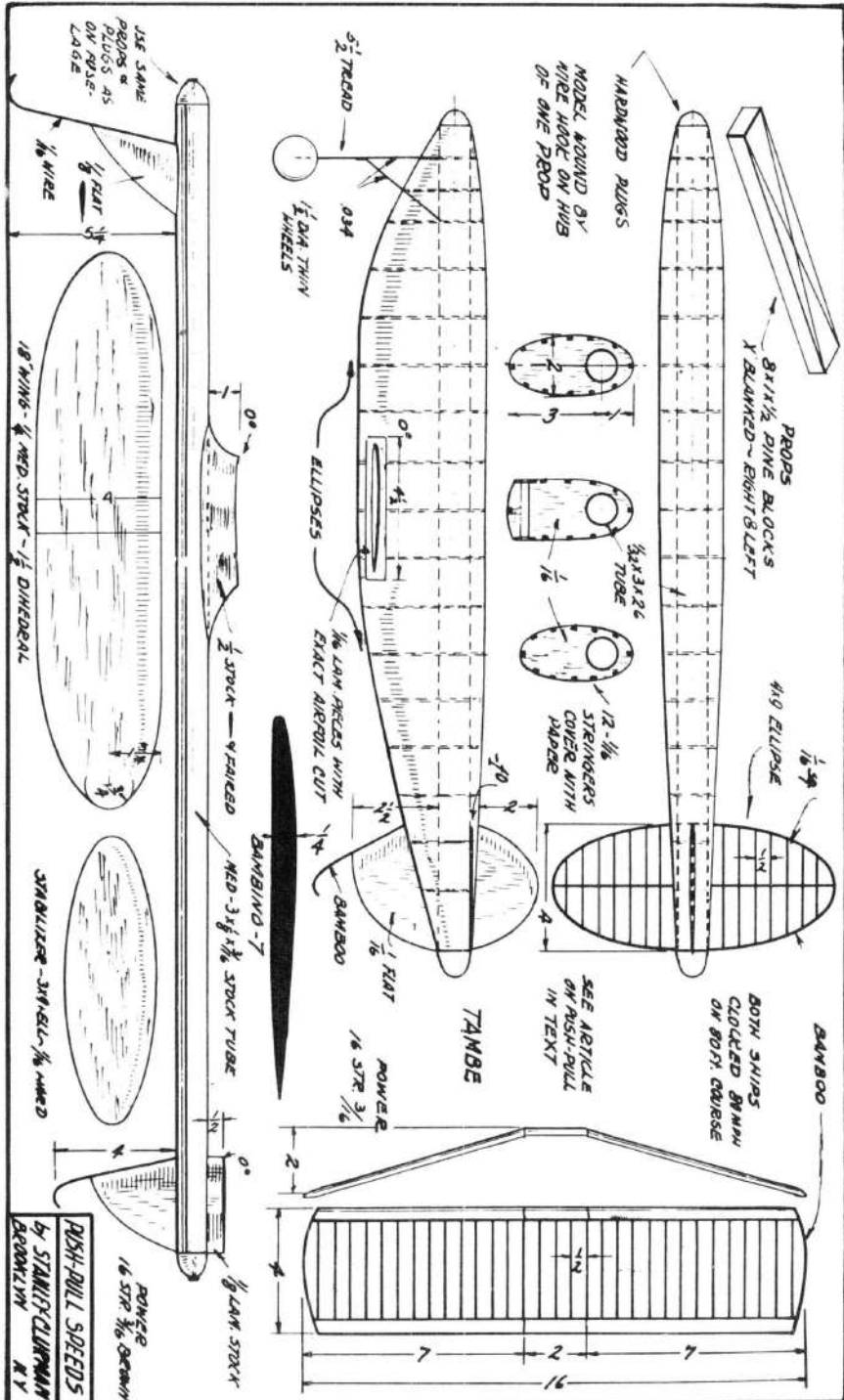
STAB & RUD. 1/16 SHEET

RICHARD'S AIRFOIL $1\frac{1}{8}$ RIBS

FLYING SCALE~BROWN B-3

by RICHARD SCHUMACHER - OATLAND, CAL.

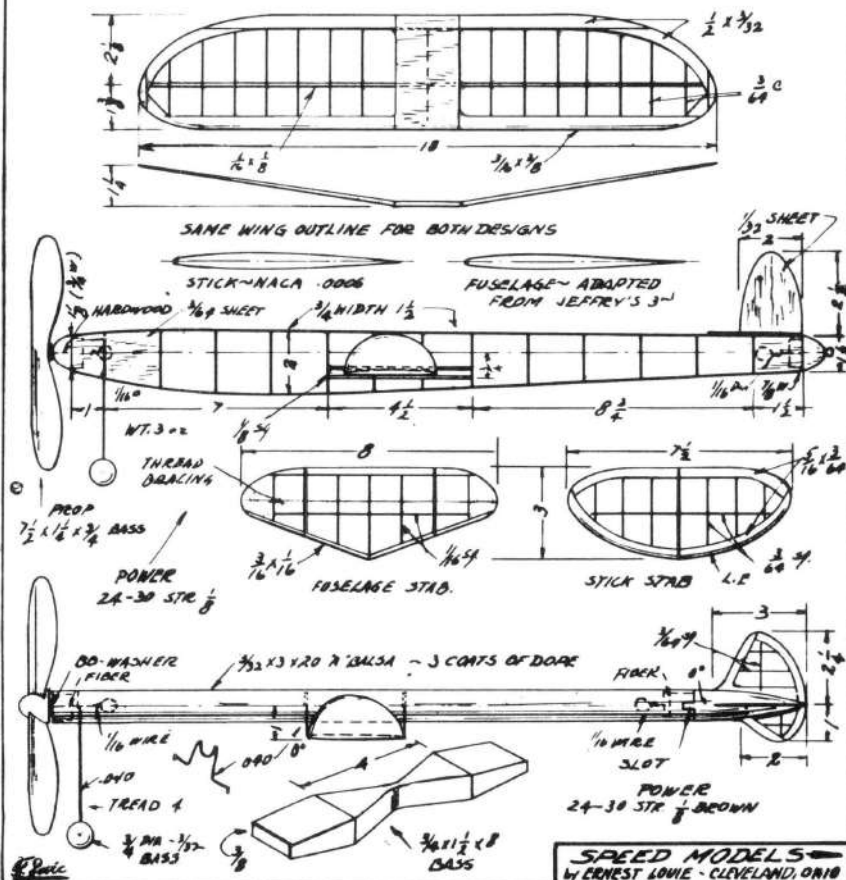


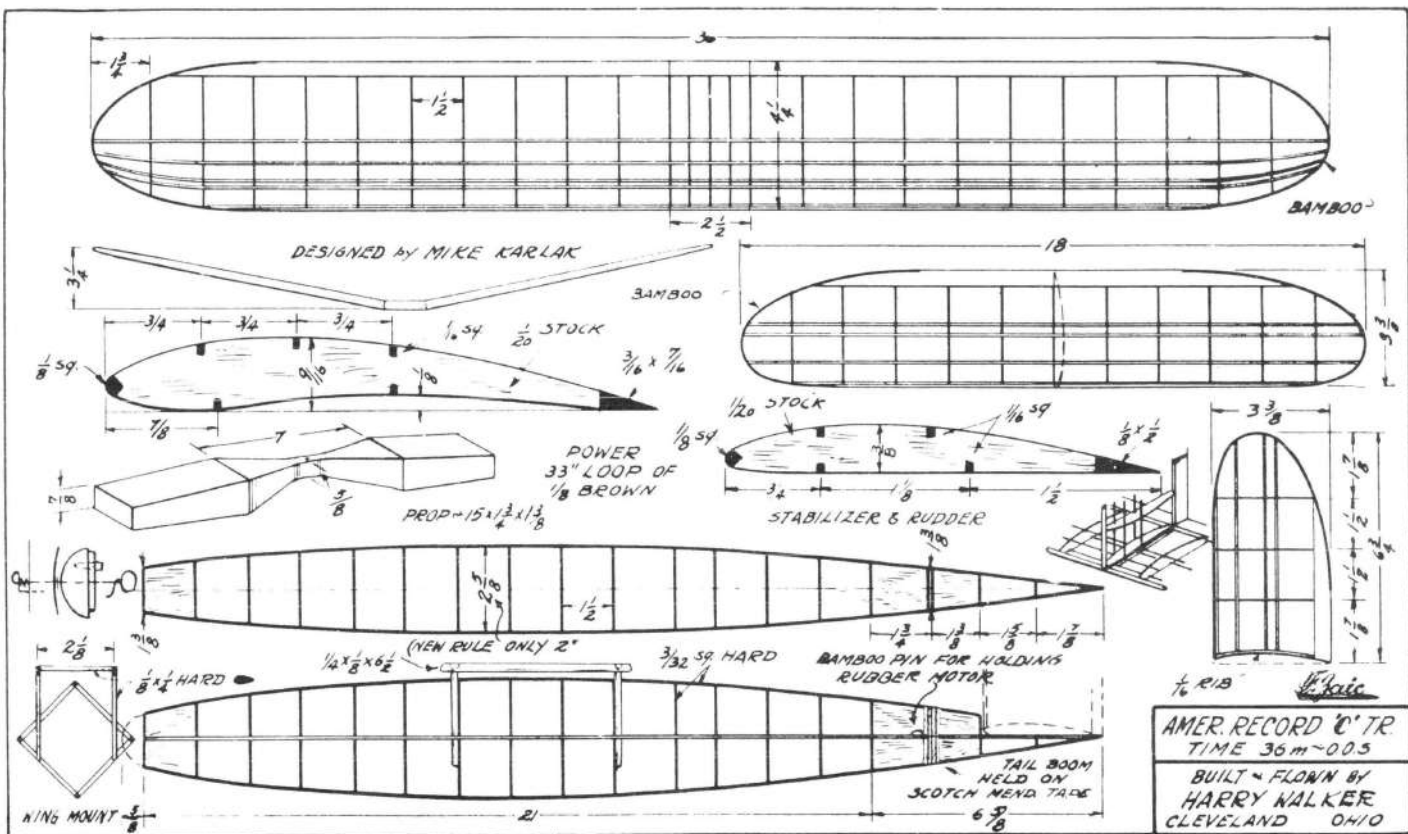


The features incorporated in the models shown below are the results of five other speed models. Features and reasons:

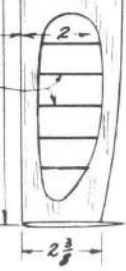
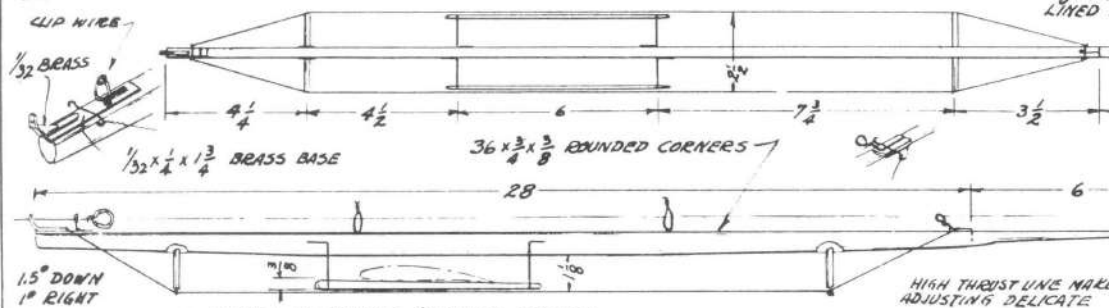
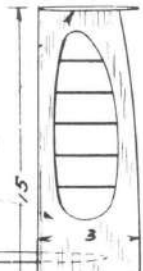
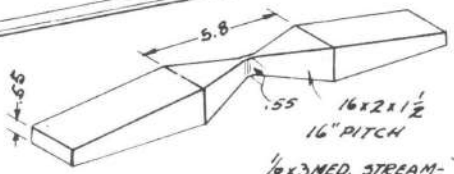
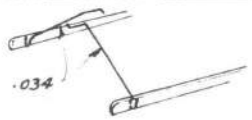
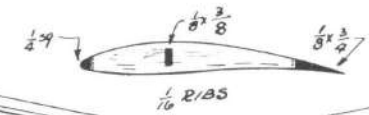
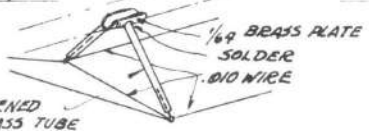
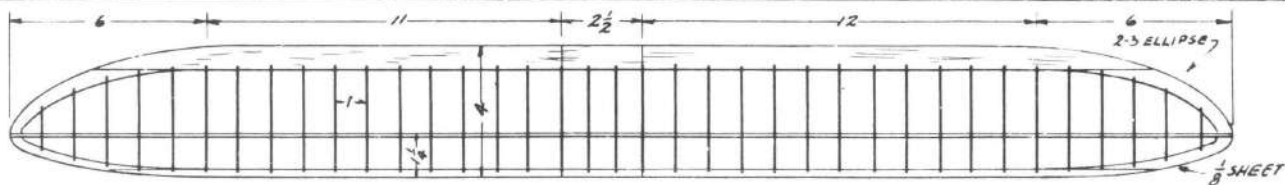
- 1.-Low wings are used to prevent the model from diving at the end of the flight and to keep the stabilizer clear of downwash.
- 2.-Twin rudders are effective in smoothing the rear airflow.
- 3.-Use hardwood front bulkhead and hardwood plug to prevent smashes in head-on crash and to provide solid base for E-Bs.
- 4.-Have rubber motor shorter than the distance between the two hooks for greater power on fewer winds.
- 5.-Nose plug should be removable but for flights cement it in place to prevent it from twisting or becoming loose.

Regarding the performance: The planes fly close to the ground and land almost level. They had little trouble in keeping within the required 30' x 80' course since they are not troubled to a large extent by torque when hand wound. But when fully wound with winder, the torque is quite apparent and extreme care must be exercised when flying these winged bullets.--I am confident that they can do in excess of 60 m.p.h., judged by the standard method.





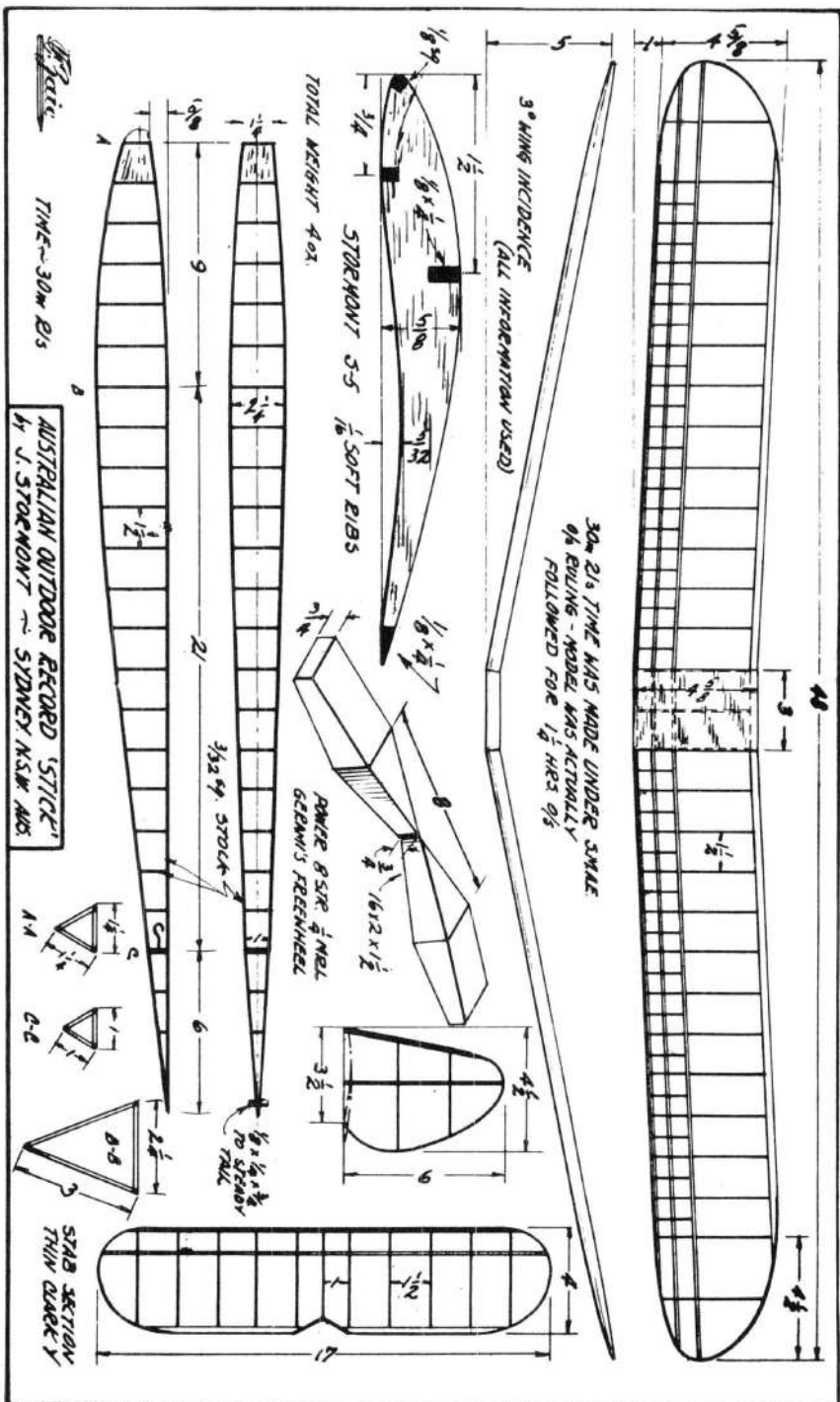
WEIGHTS
 STICK 1.16
 WING 1.07
 TAIL .23
 PROP .34
 TOTAL 2.80
 RUBBER 1.55
 TOTAL 4.35



POWER - 21 STRANDS 1/8 BROWN 32" LONG
 WIND 340 - INSERT A LOOP FOR RUBBER
 TENSIONING SEE PAGE 1025 TURNS

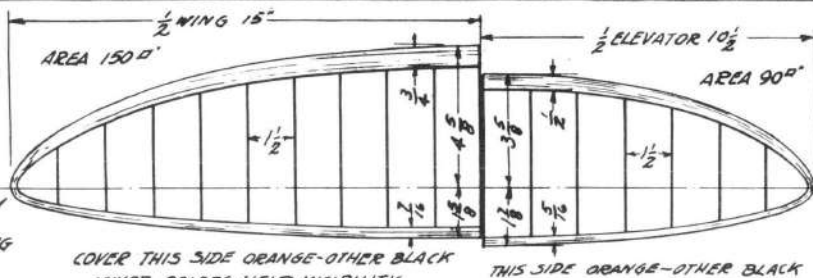
HIGH THRUST LINE MAKES
 ADJUSTING DELICATE

JR. BIRD MEN RECORD STICK 51/4 27 5/8
 by ALBON C. COWLES JR. ATLANTA, GA.



WEIGHTS
 WING .50
 ELEVATOR .27
 STICK .64
 PROPS .58
 1.99
 RUBBER 2.51
 TOTAL 4.50

25% GIVES
 SLIGHT WARPING
 STABILIZATION
 EFFECT



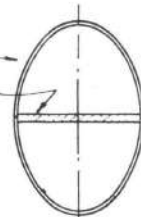
COVER THIS SIDE ORANGE-OTHER BLACK
 MIXED COLORS HELP VISIBILITY

THIS SIDE ORANGE-OTHER BLACK

BUILT-IN DIHEDRAL 1/2 OF ACTUAL
 BALANCE BENT NATURAL - SEE
 TEXT FOR INSTRUCTIONS

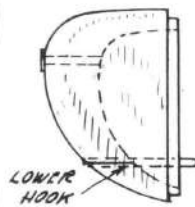
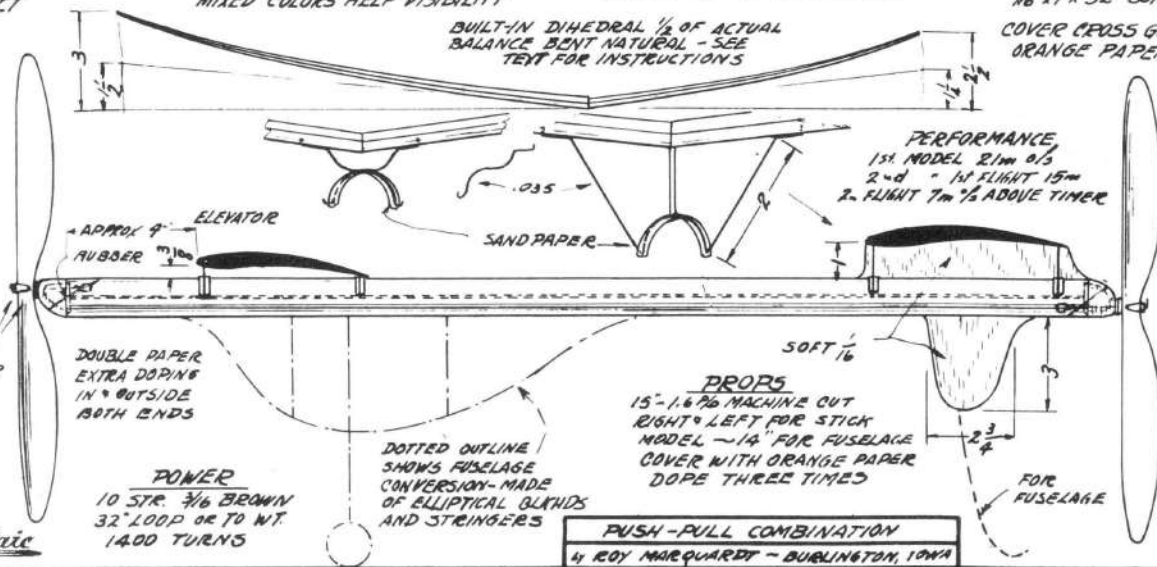
MARQUARDT 3-2
 FOR AIRFOIL ORDINATES
 AND WING CONSTRUCTION
 SEE TEXT

STICK
 2-1/32 x 2 x 32 MED
 1/16 x 1 x 32 SOFT
 COVER CROSS GR
 ORANGE PAPER



6 COATS OF
 DOPE

PERFORMANCE
 1st. MODEL 21m 0/5
 2nd - 1st FLIGHT 15m
 2. FLIGHT 7m 1/2 ABOVE TIMER

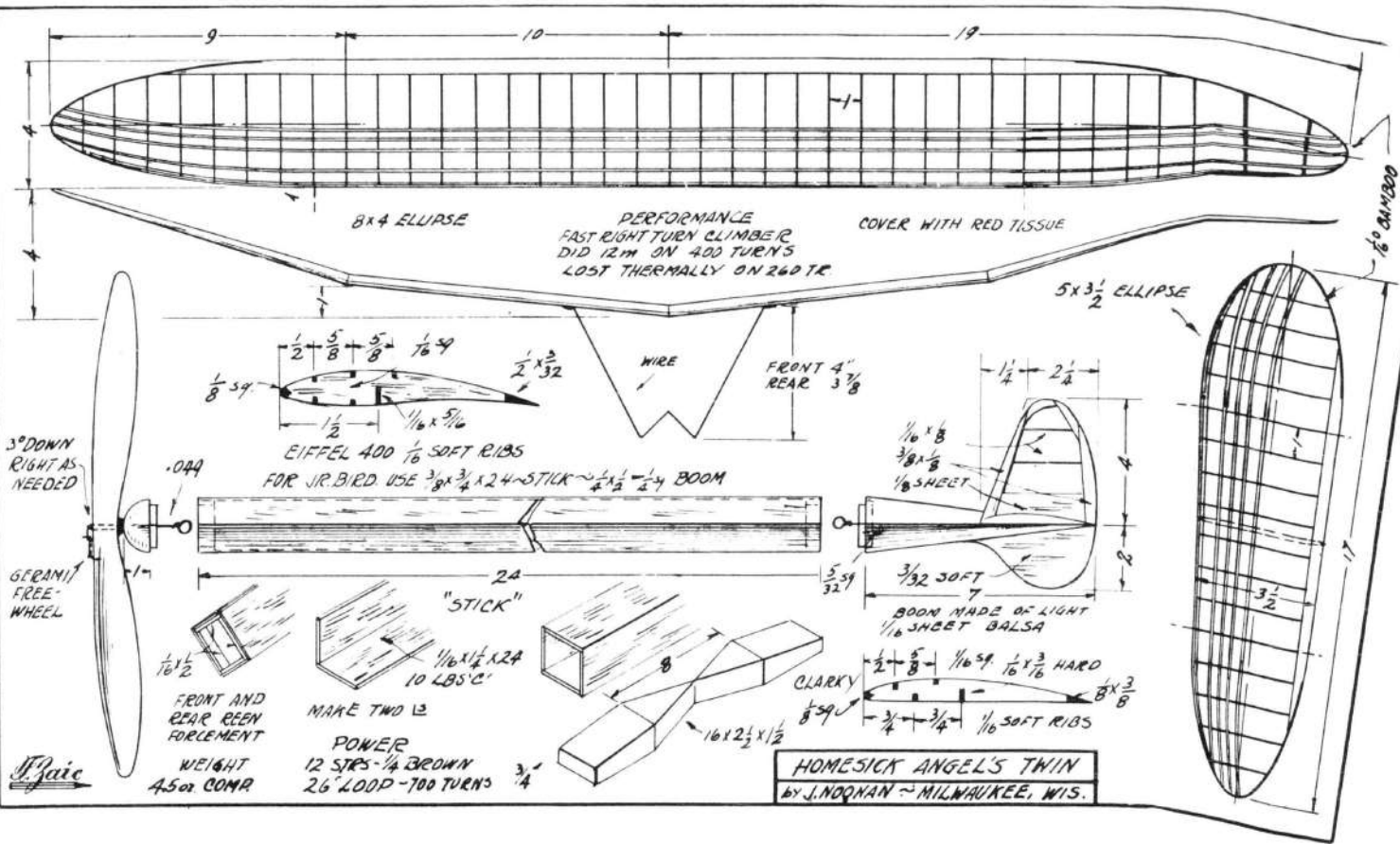


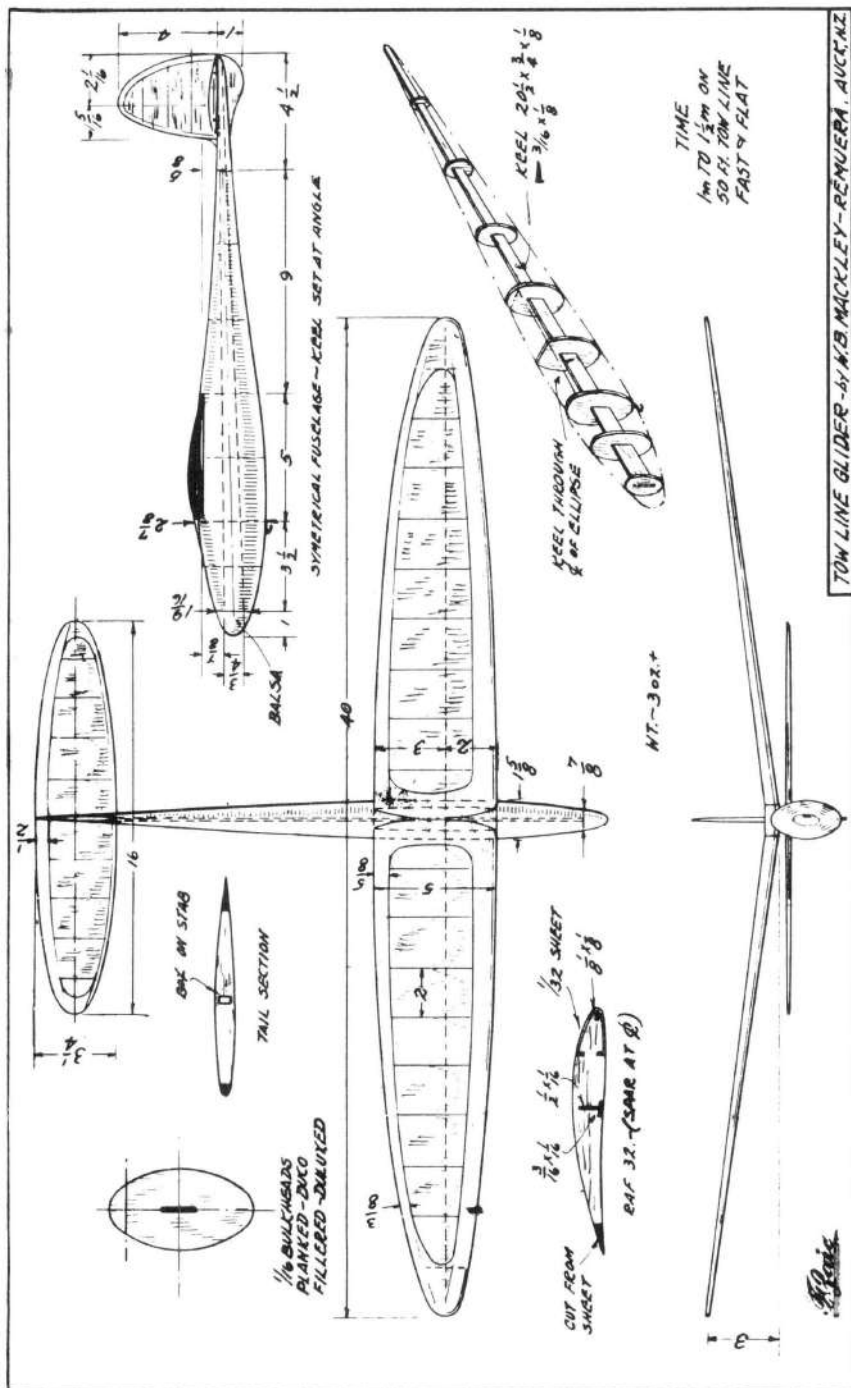
NOSE PLUGS
 CARVED FROM
 1x1/2 x 1/2 SOFT
 HOLLOW + COAT
 WITH CEMENT

PROPS
 15-1.620 MACHINE CUT
 RIGHT + LEFT FOR STICK
 MODEL - 1/4\"/>

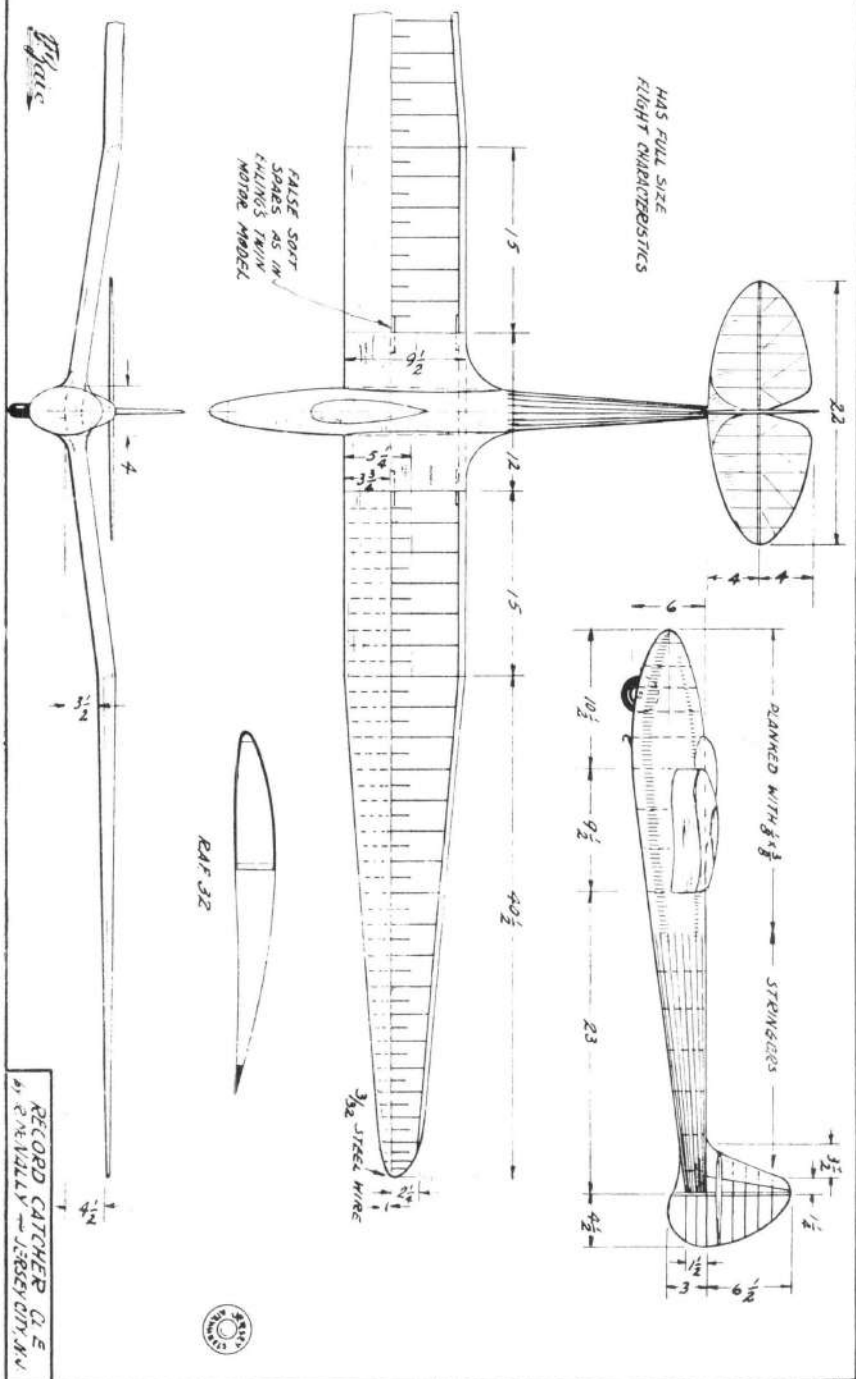
PUSH-PULL COMBINATION
 4 ROY MARQUARDT - BURLINGTON, IOWA

Paic

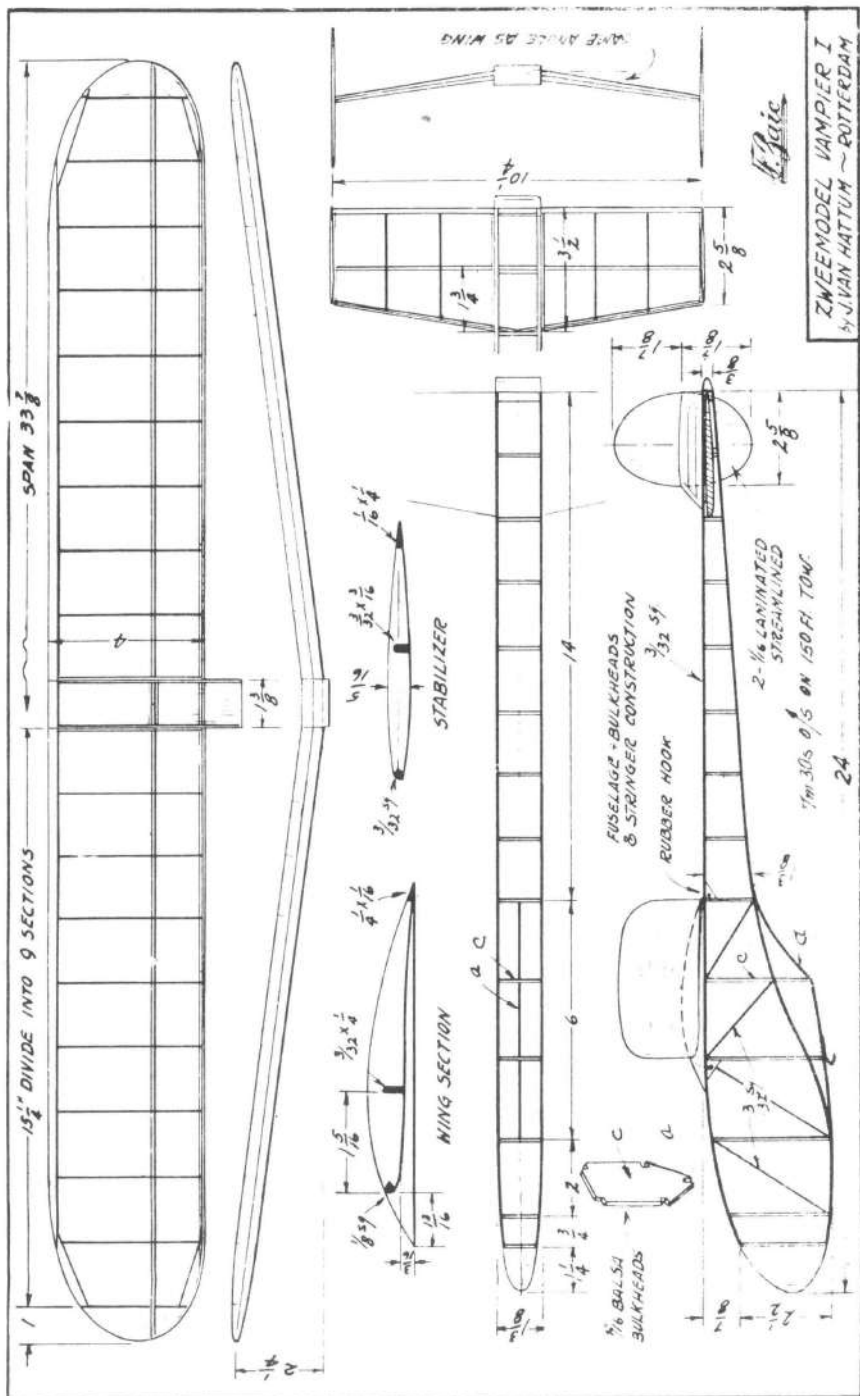


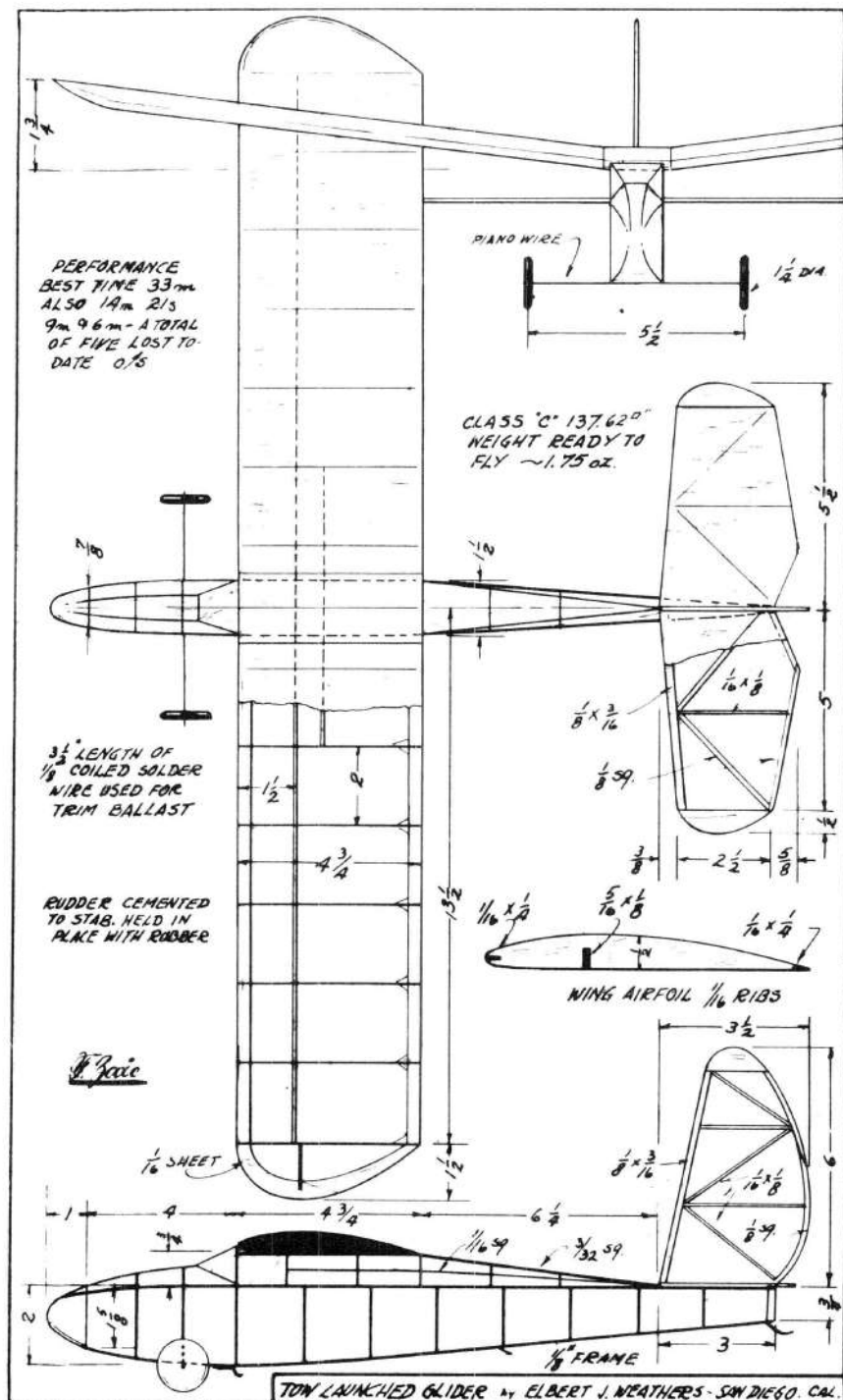


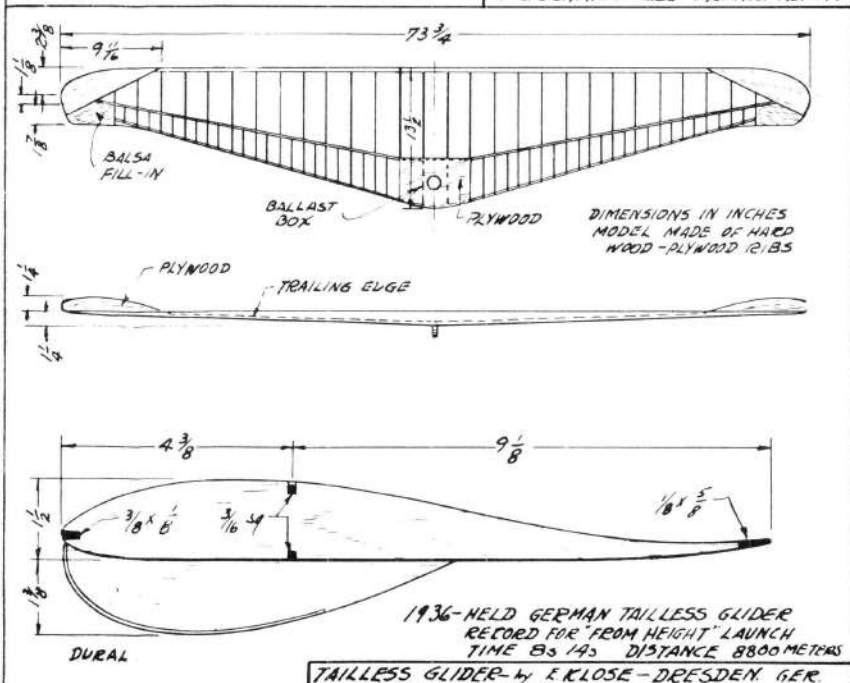
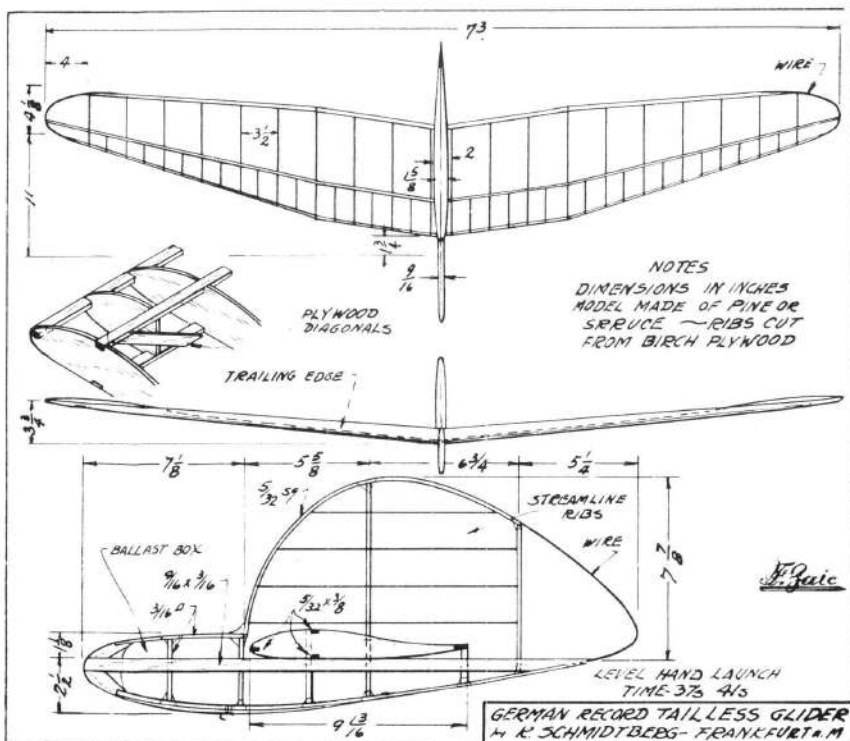
TOW LINE GLIDER - BY J. B. MACKLEY - REMUEPA, AUCTION

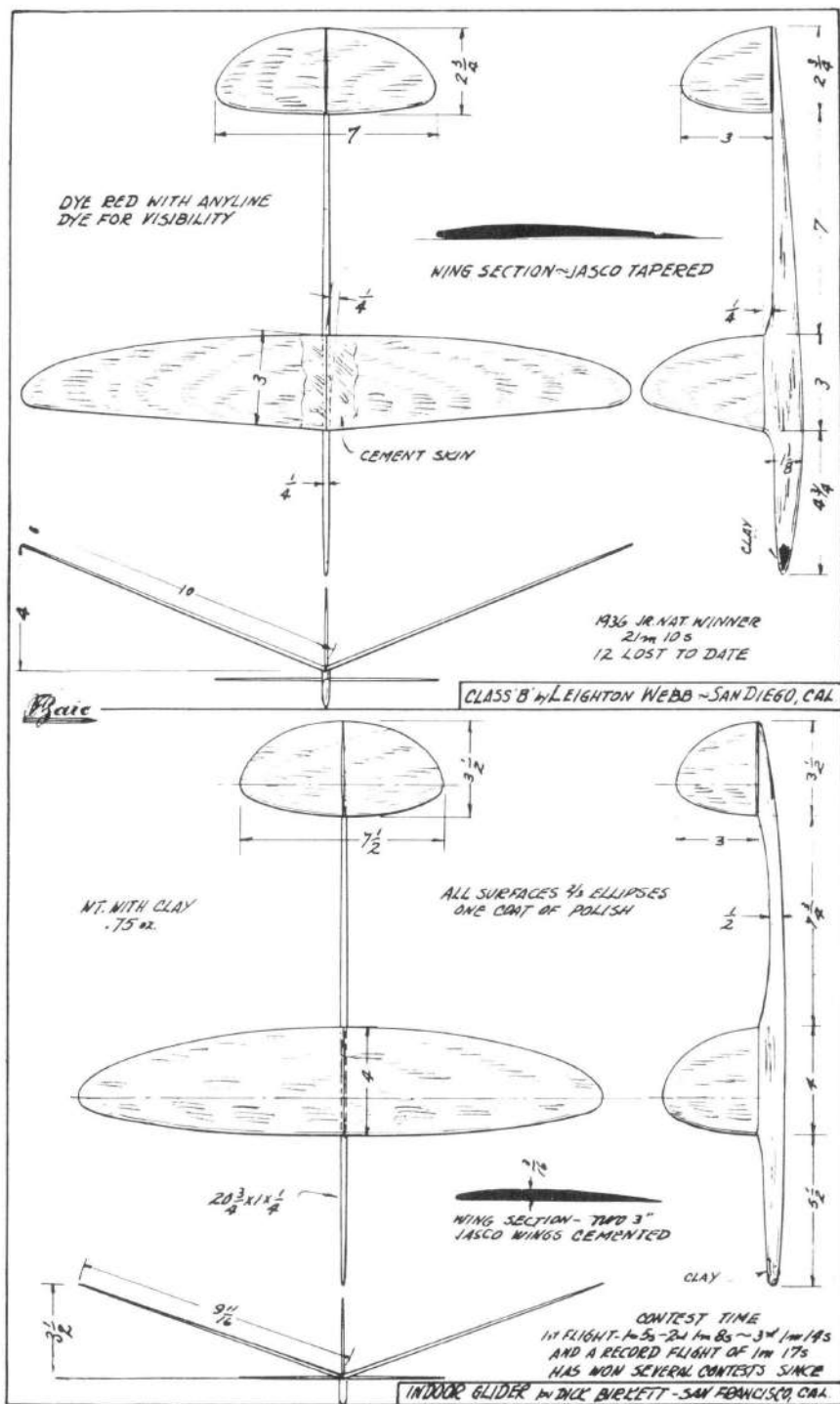


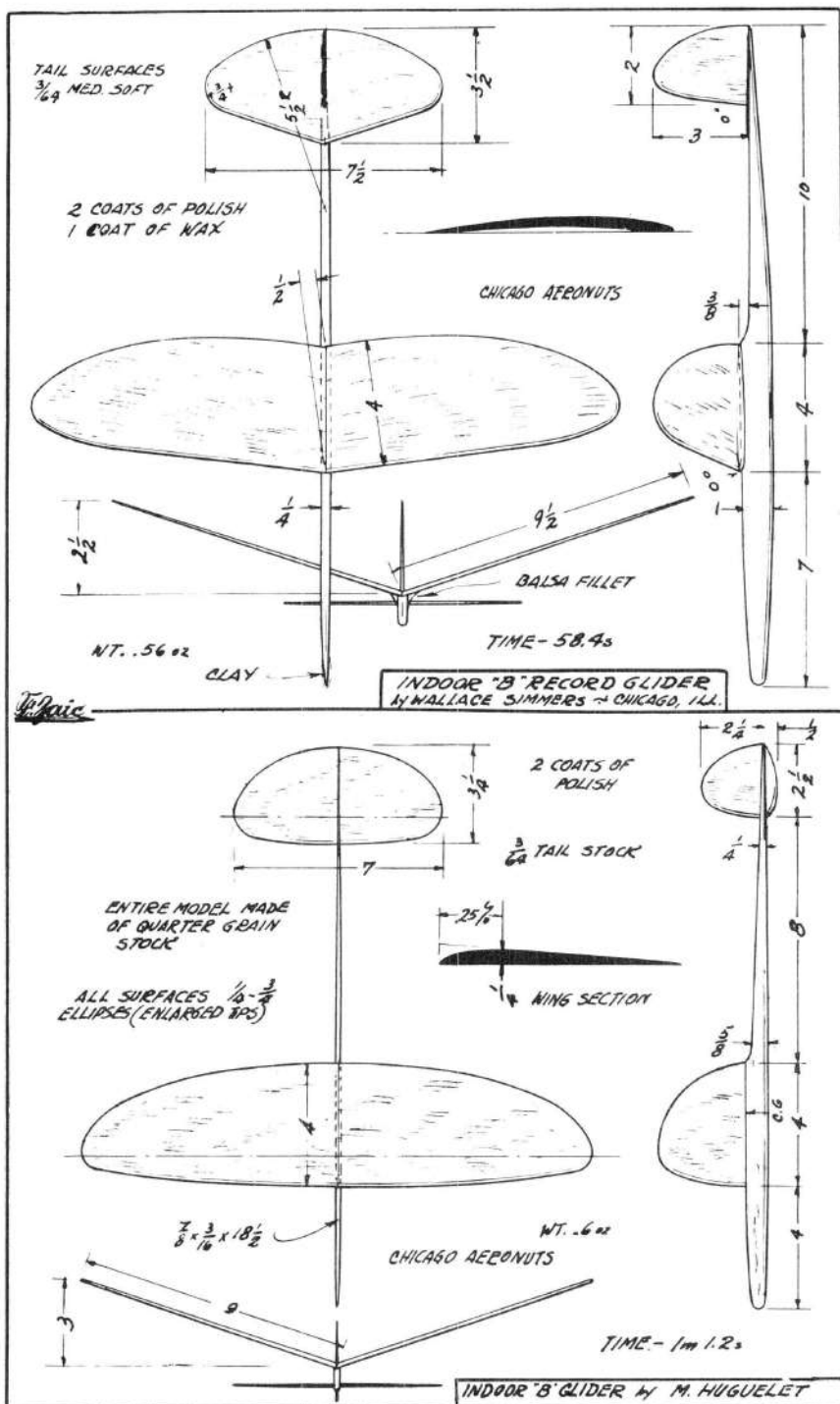
RECORD CATCHER CLE
b) MENALLY - JERSEY CITY, N.J.

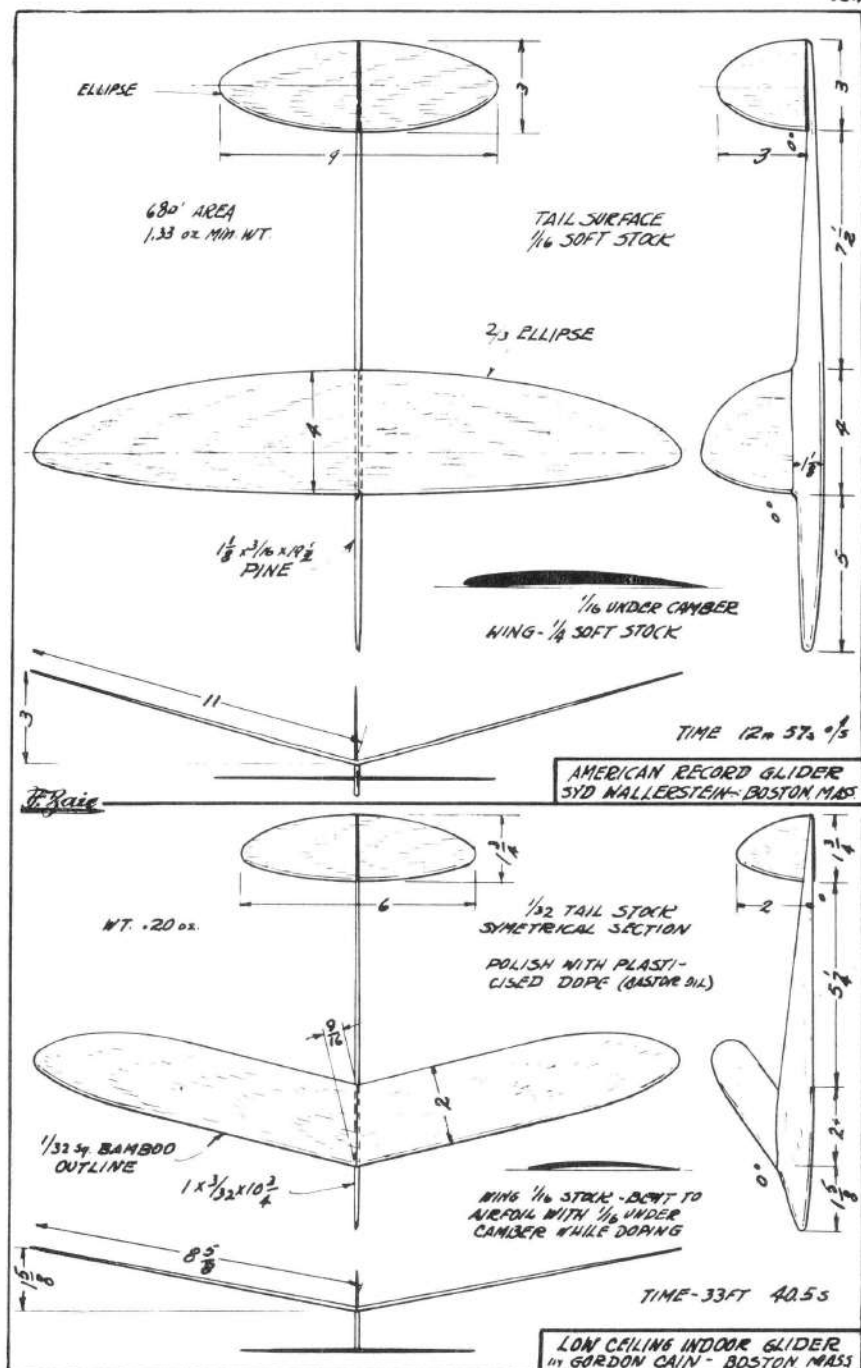


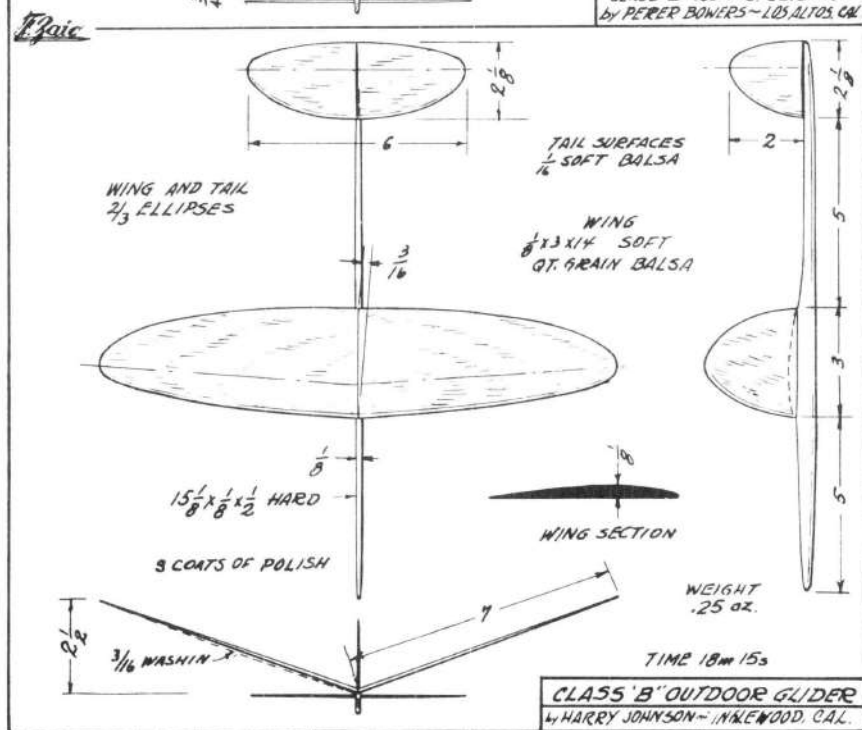
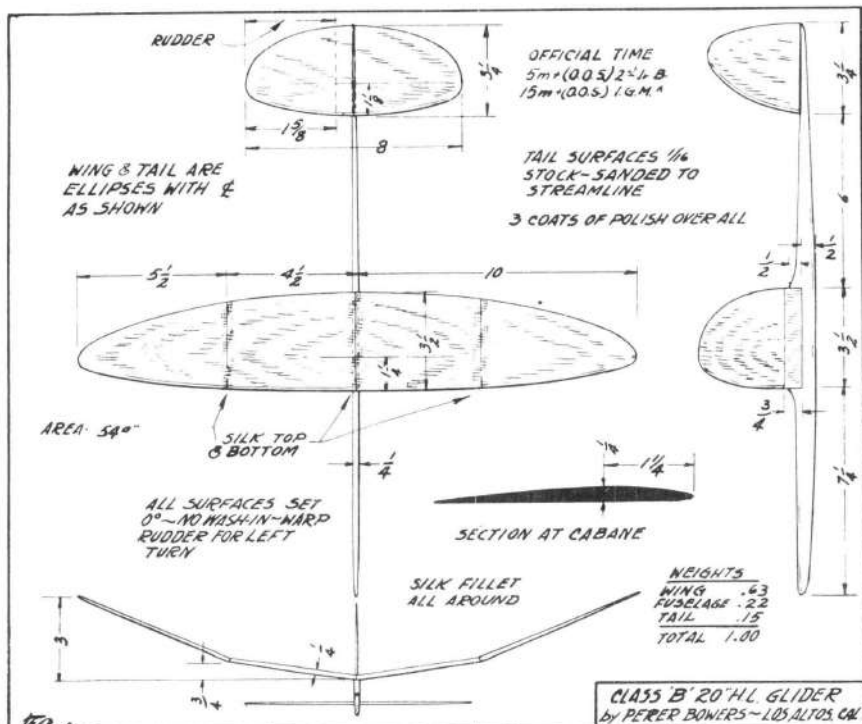


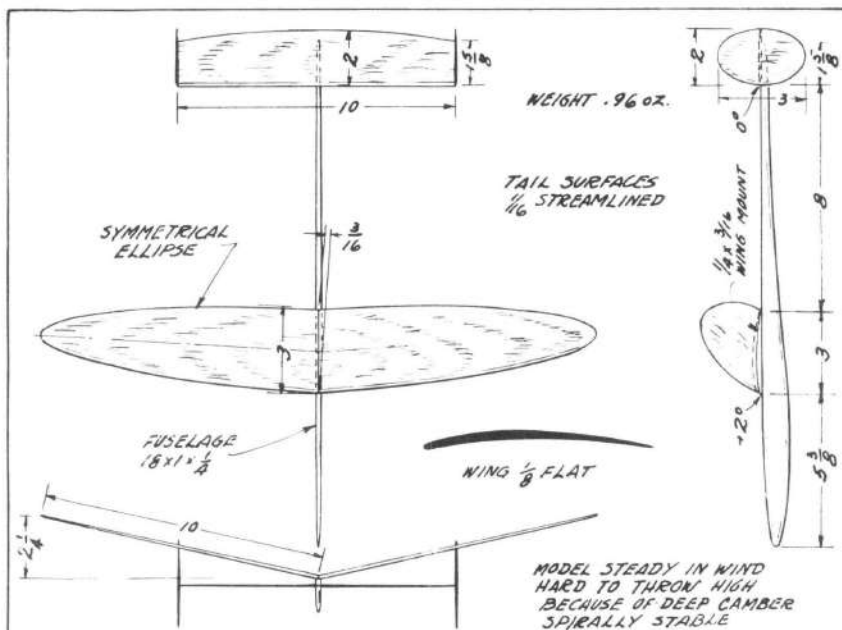




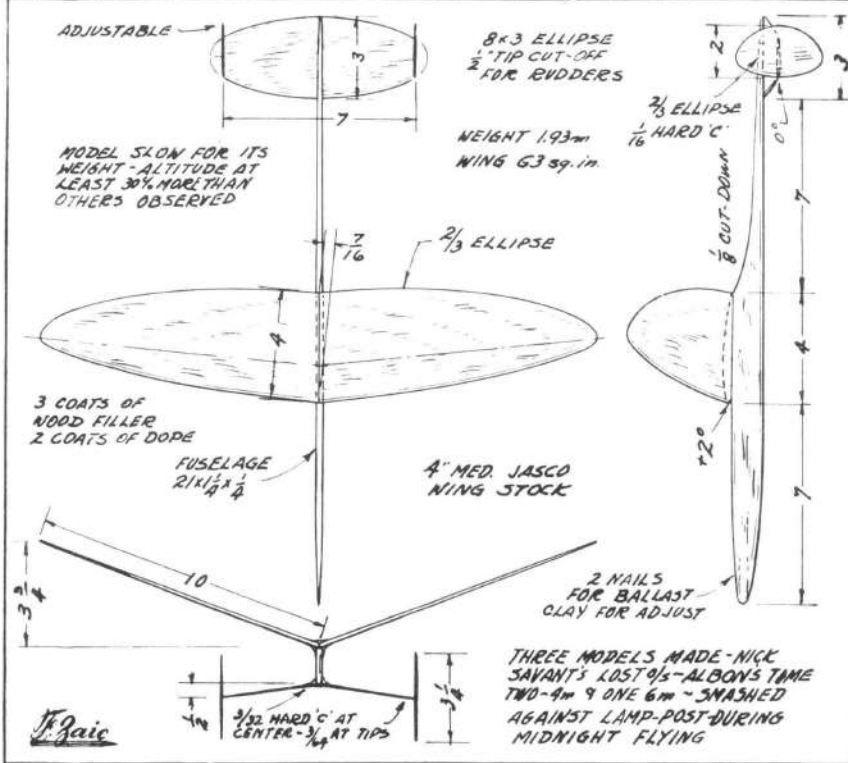


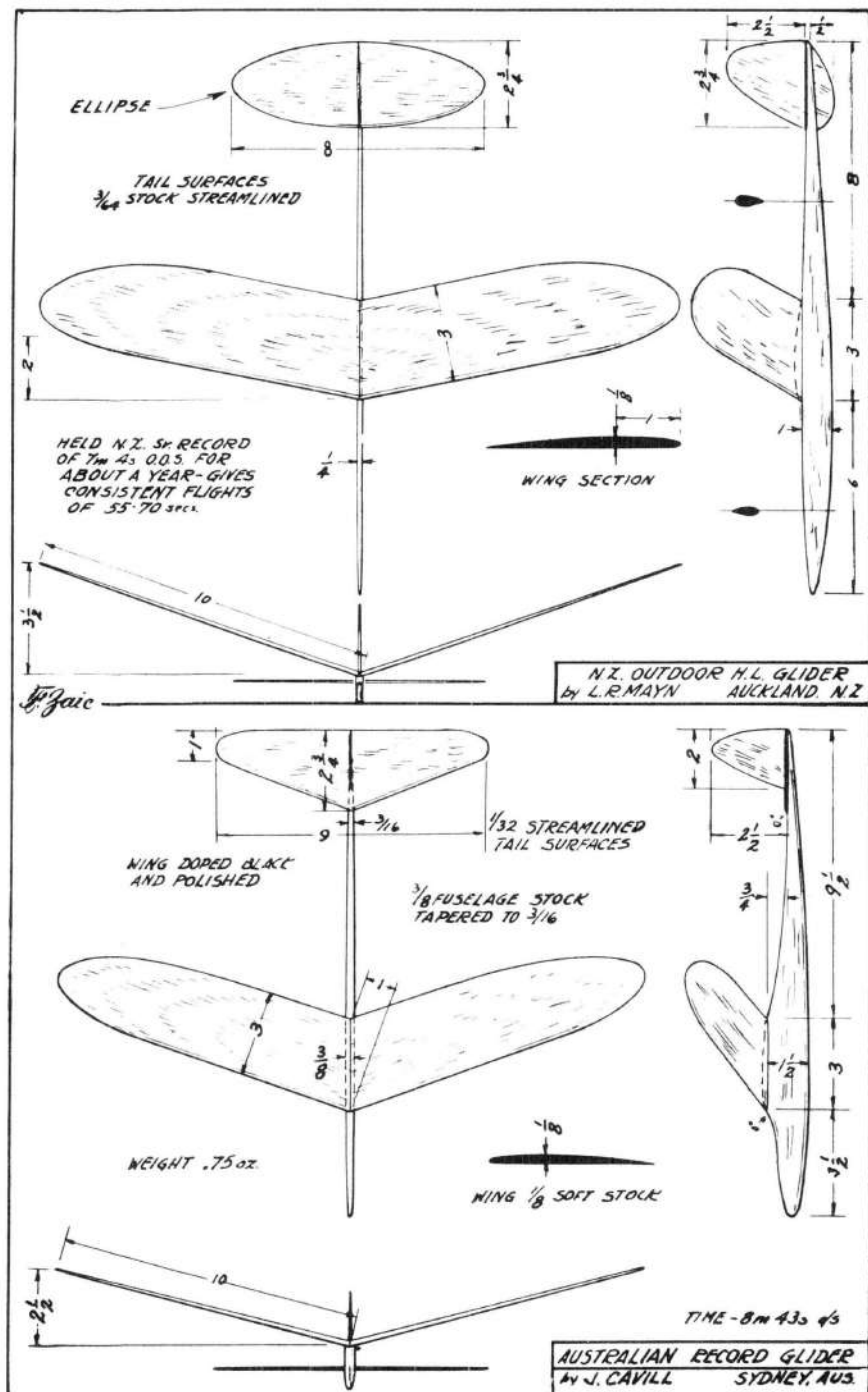


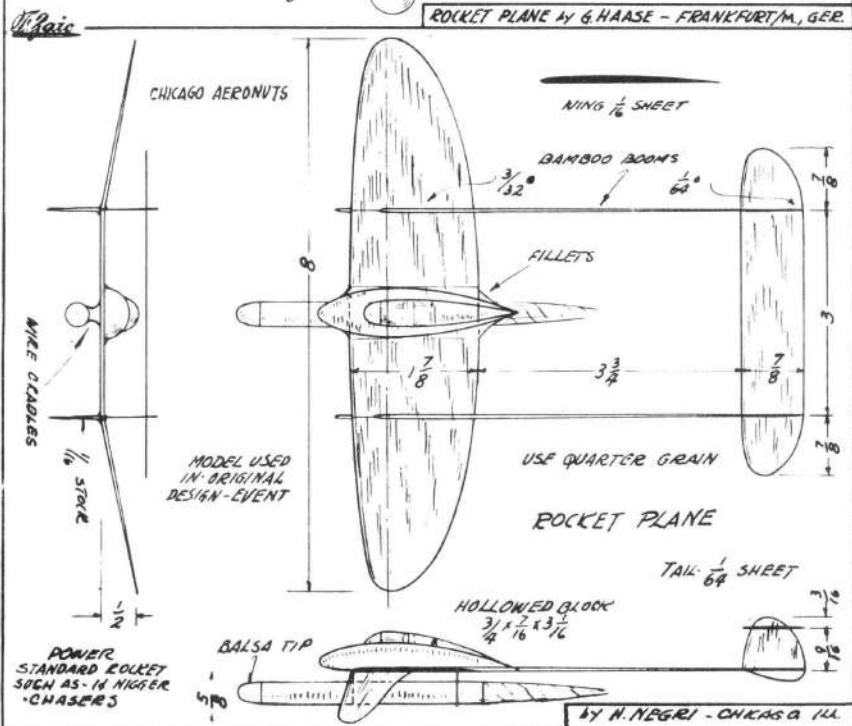
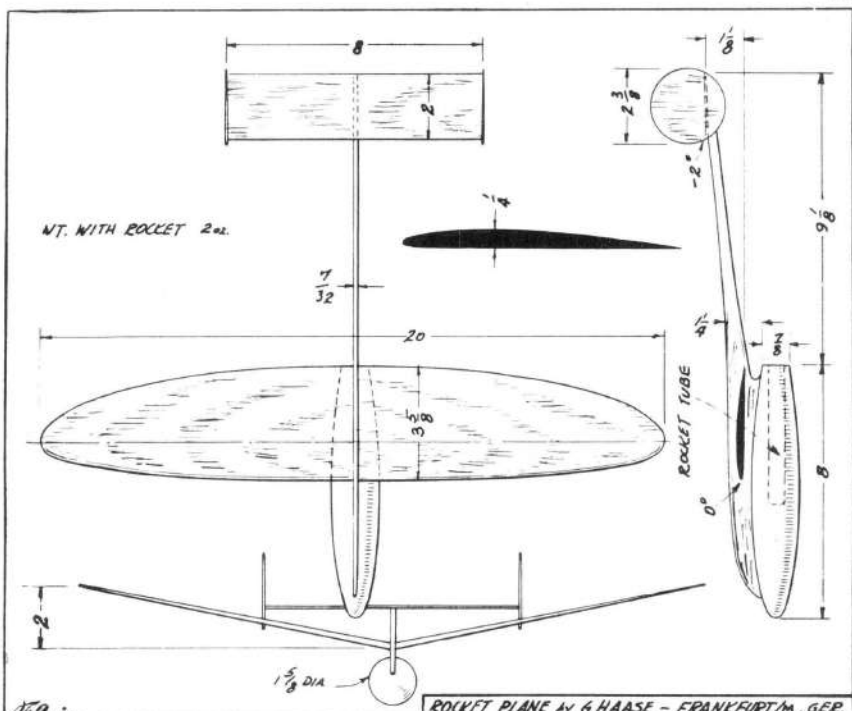


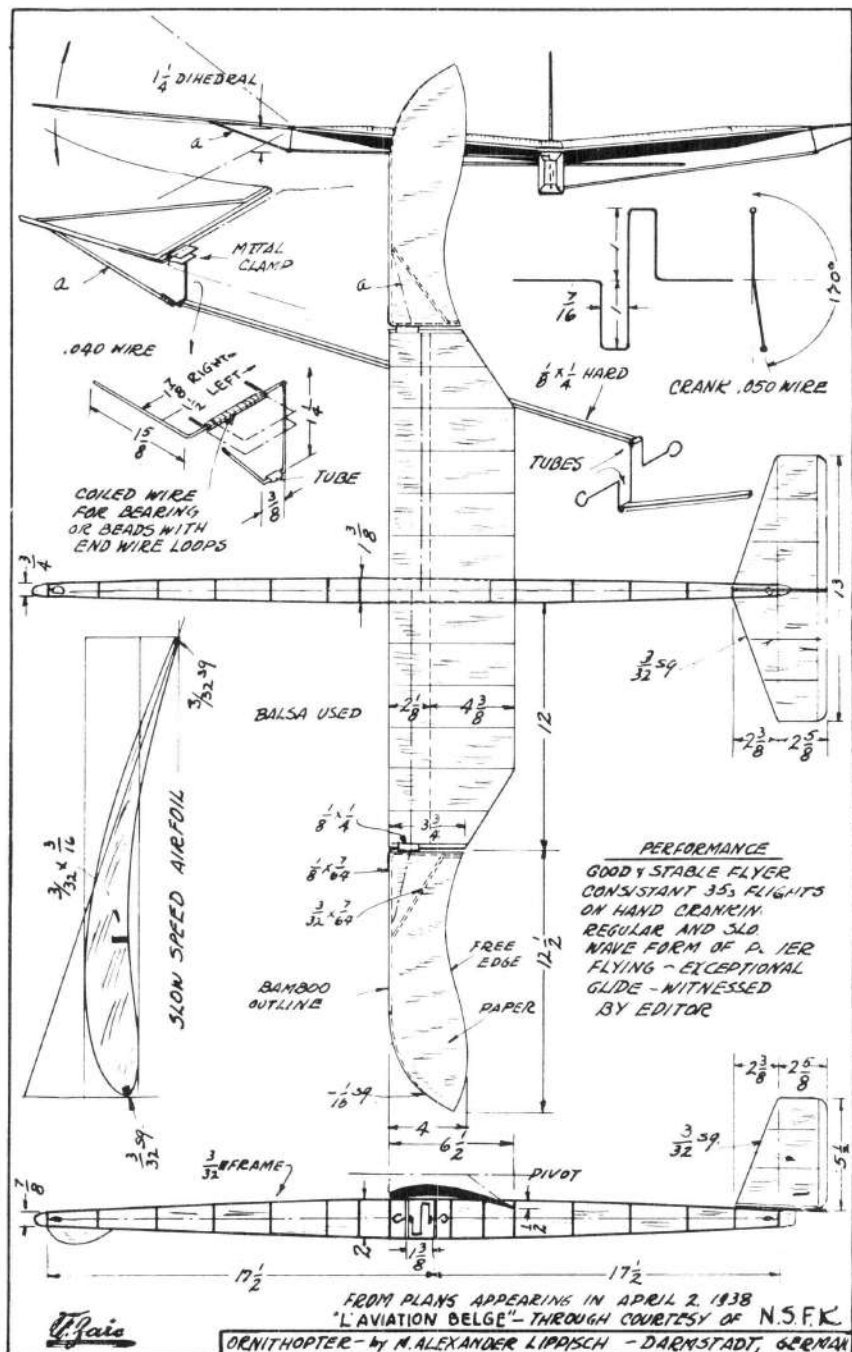


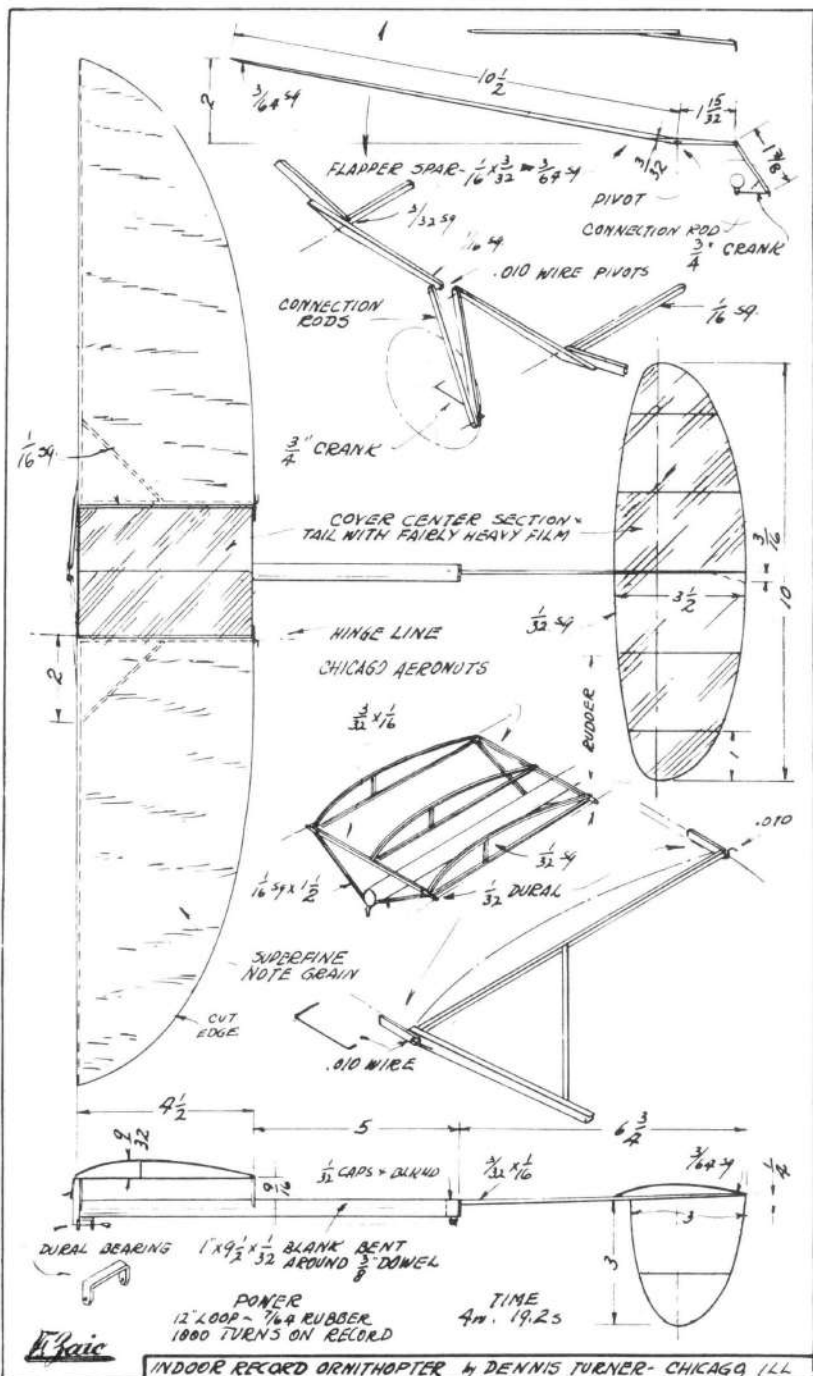
HAND LAUNCHED GLIDERS ~ by ALBON COWLES - ATLANTA, GA



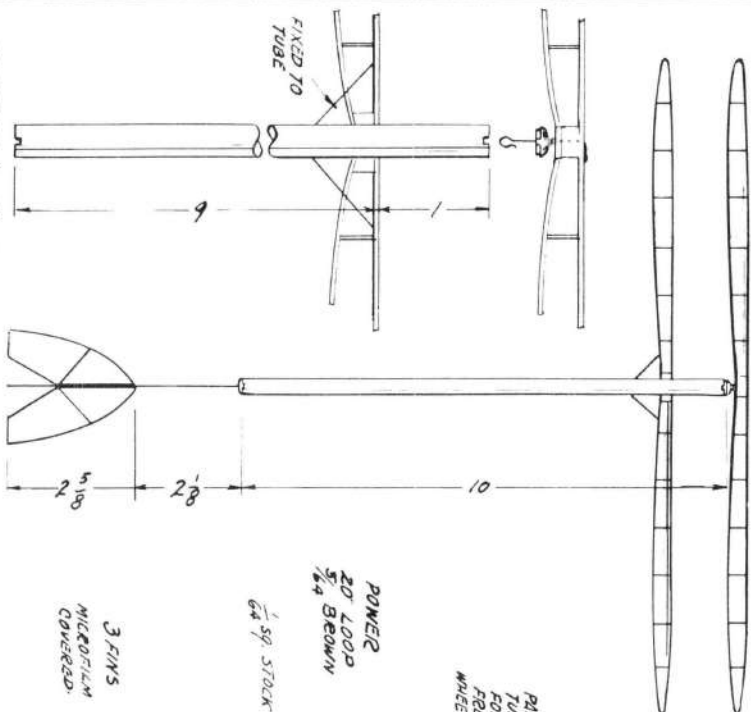








MOTOR TUBE $\frac{1}{4} \times \frac{1}{8} \times 10$

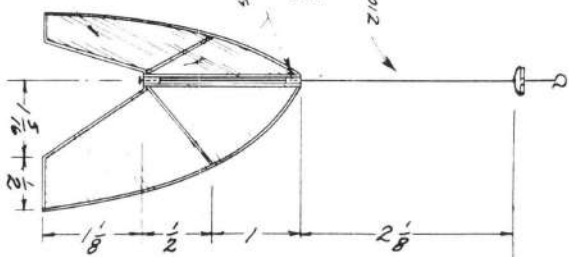


CHICAGO AERONAUTS

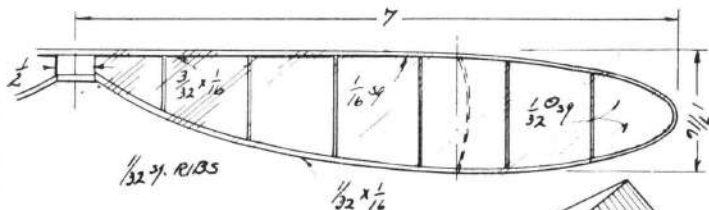
3 FINS
MICROFILM
COVERED.

POWER
20' LOOP
 $\frac{1}{4} \times \frac{1}{8} \times 10$
BROWN

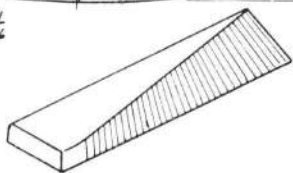
PAPER
TUBES
FOR
FREE-
WHEELING



1/16



2 MICROFILM PROPS - RIGHT
AND LEFT - EQUAL TO $\frac{1}{4} \times \frac{1}{8} \times \frac{1}{4}$
BLOCK - MADE ON BLOCK
MED. BALSA USED



5 1/2" R. HELICOPTER
DESIGNED BY
RICHARD OBARSKI
CHICAGO ILL.

WEIGHTS	
WING	.004
TAIL	.005
TUBE	.010
VANES	.010
PROP	.005
TOTAL	.034

CEMENT WING TO THE
TUBE AT BEST SLIDE
POSITION. ADJUST WITH
DOWNTHRUST LINE - CIRCLES
TO RIGHT

.014 WIRE

CHICAGO AERONUTS

O TUBE
 $\frac{1}{64} \times \frac{5}{8} \times 2\frac{1}{4}$

PLUGS
1/16 SHEET WITH
1/16 CROSS BRACES

-3-

1

3-

100

-7-

10" $\frac{1}{4}$ QUARTER GRAIN BENT AROUND $\frac{5}{16}$ DOWEL

$$\frac{3}{32} \times \frac{1}{16}$$

$-\frac{1}{64}$ OUTLINE-ALLOW TO
FLEX 7

VANES
 $\frac{1}{2}$ TRUE —
ELLIPSE

$$\frac{1}{30} \times \frac{1}{32}$$

WING & TAIL - $\frac{1}{4} \times \frac{3}{4}$ ELLIPSE
WING AREA 30" VANS 33"

VANES $\frac{1}{64}$ 29. RIBS

NING & TAIL $\frac{1}{64}$ 39 RIBS

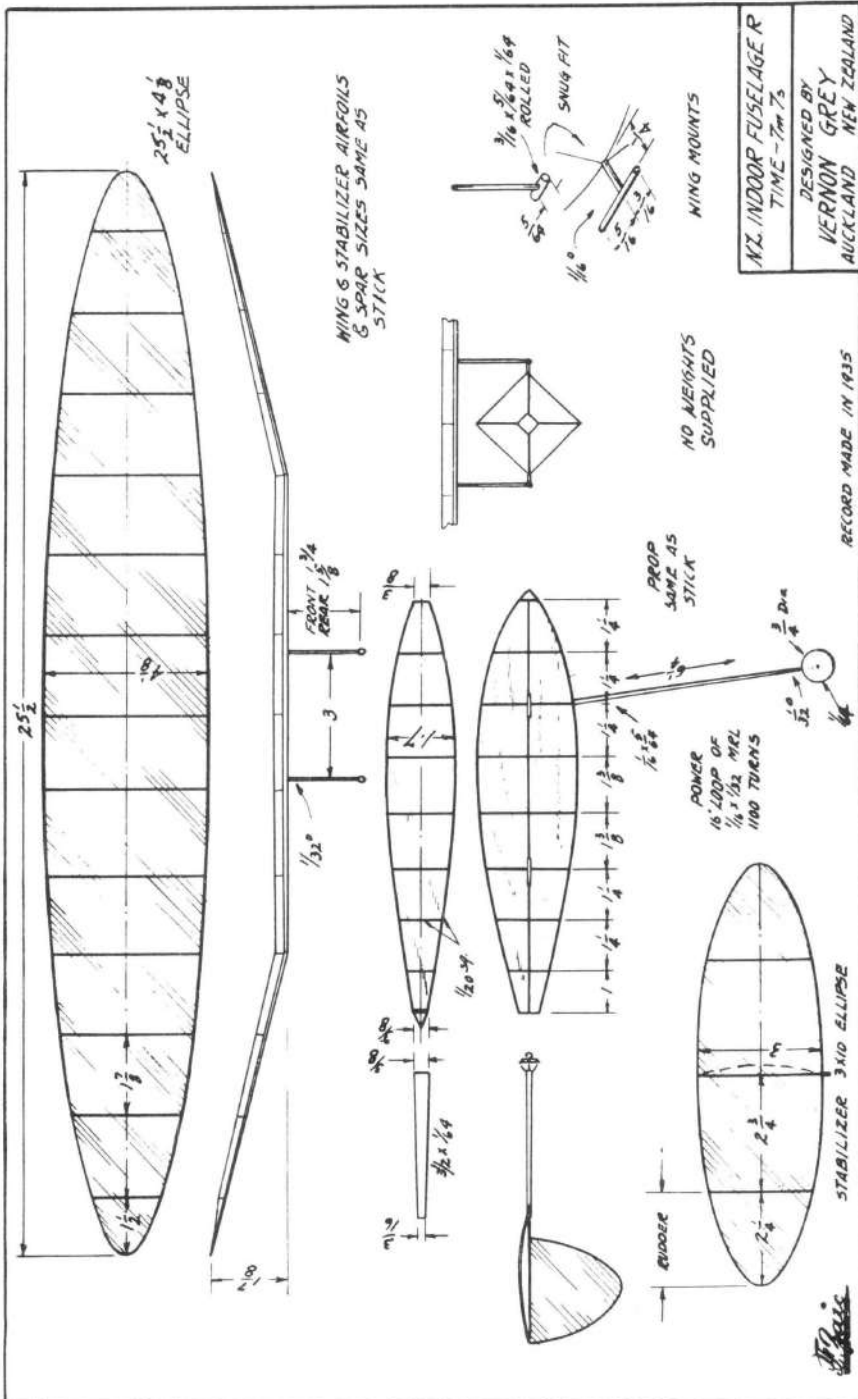
TIME - 4m 29.2s

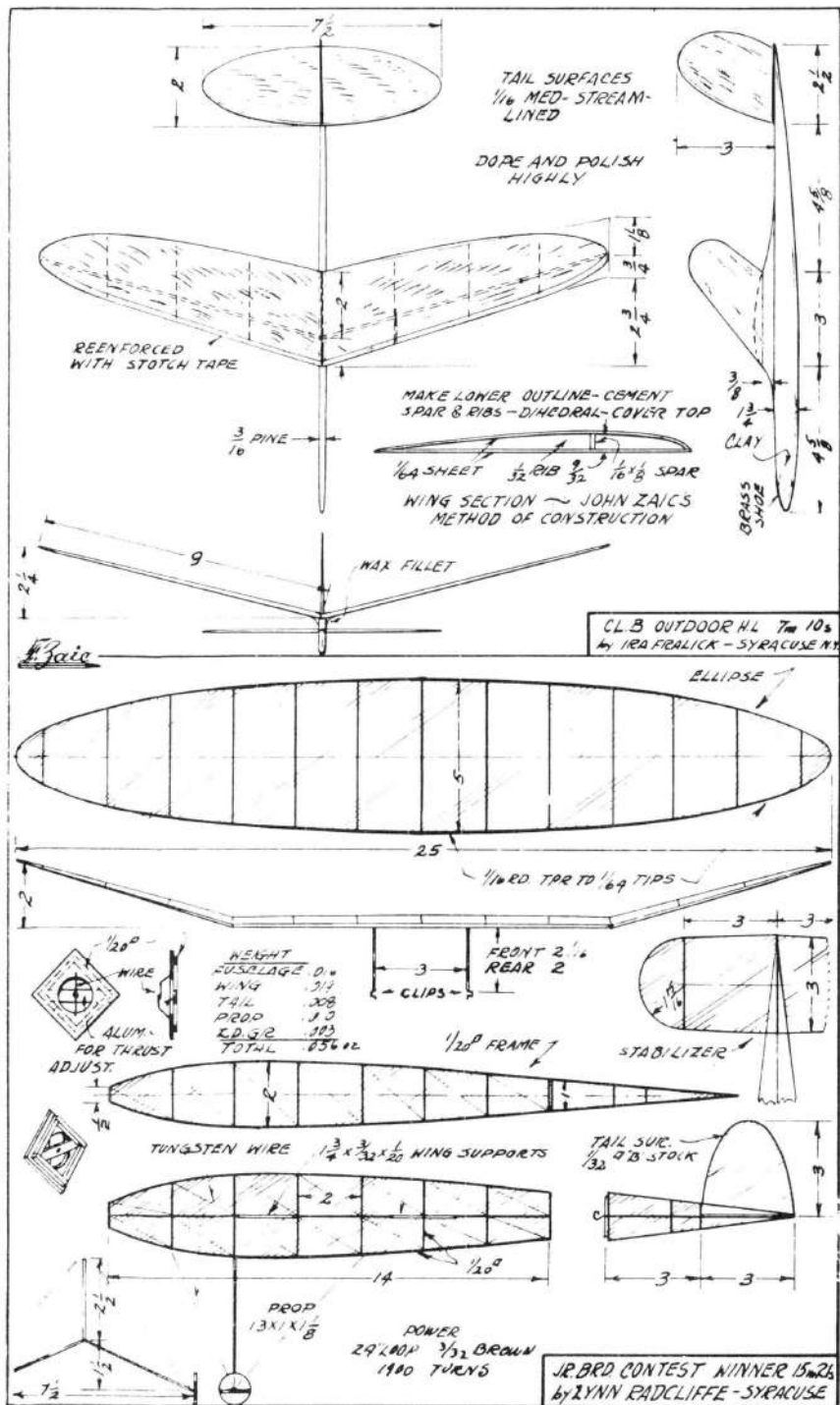
INDOOR RECORD AUTOGIRO - M. HUGUELET - CHICAGO, ILL

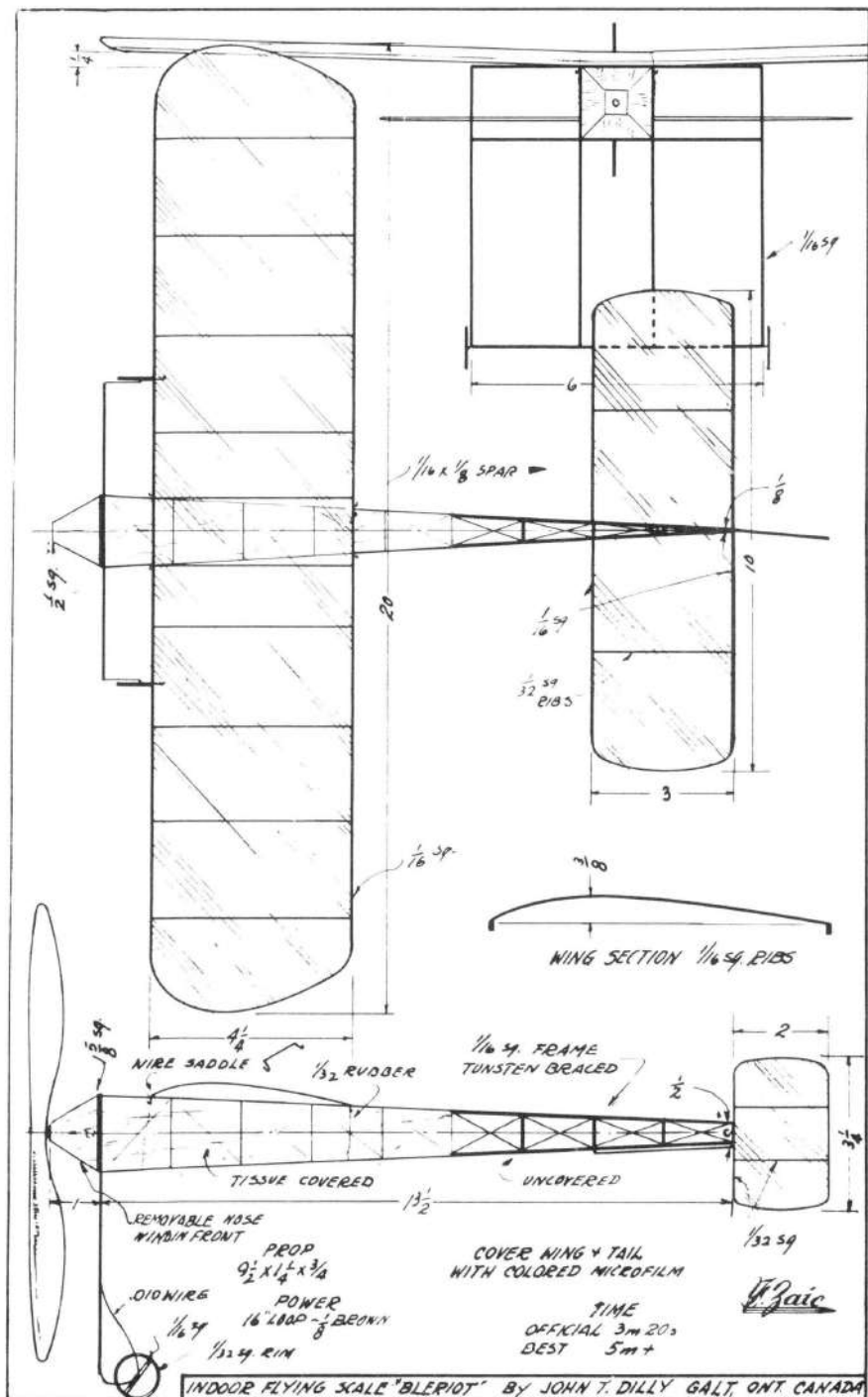
PROP
 $8\frac{1}{2} \times \frac{3}{4} \times 1\frac{1}{4}$

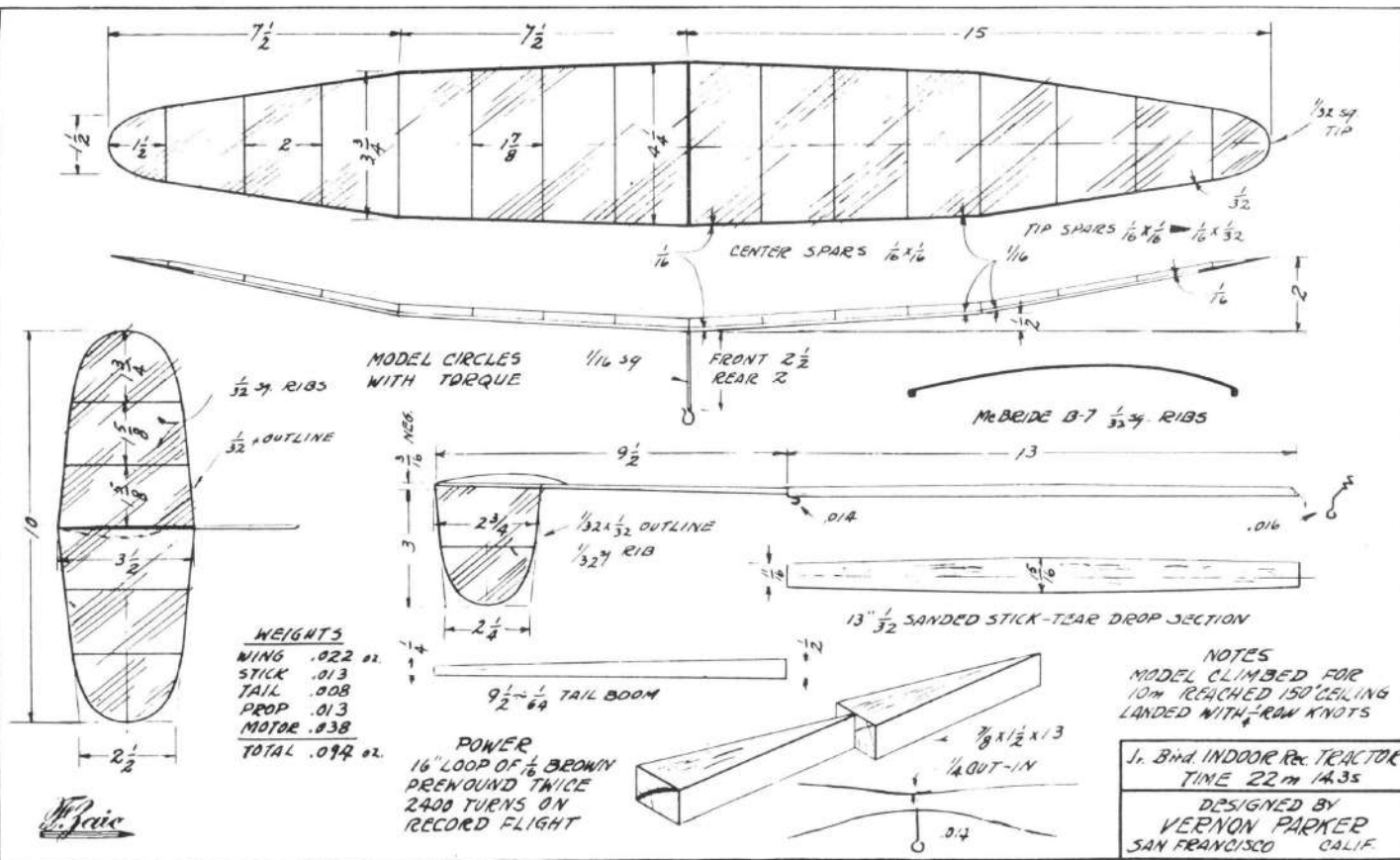
POWER
1/16 BROWN
WILL FLY
ON 3/64

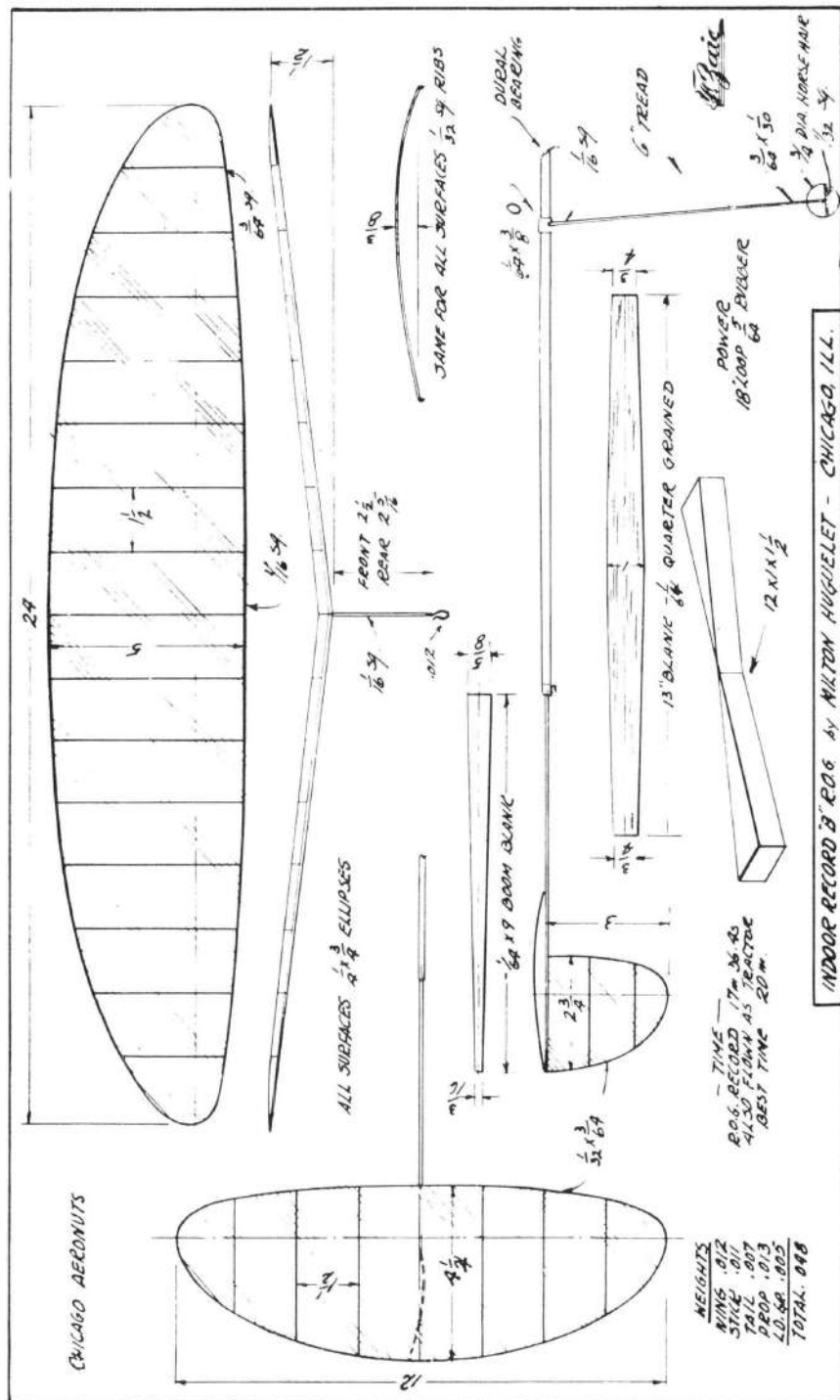
L. Price











N.Z. INDOOR RECORDER
H.L.-13m/5.2s ~ ROG-10m 4/5

H.L.-13m/5.2s~POG-10m 4/5

DESIGNED BY

VERNON GREY

AUCKLAND NEW ZEALAND

F. Fair

WING COVERED
IN ONE PIECE

MODEL FLOWN
IN 40 FOOT CEILING

NO WEIGHTS
SUPPLIED

POWER
23" LOOP OF 1/4" x 30' MPL BROWN
1650 TURNS ON RECORD X-5

$\frac{1}{4}$ GRAINED

DURAL BE.
POLISHED WITH
BIRMINGHAM CO.

 $\frac{1}{64}$ ALK

SNUG FIT IN

→ 1/2 pos

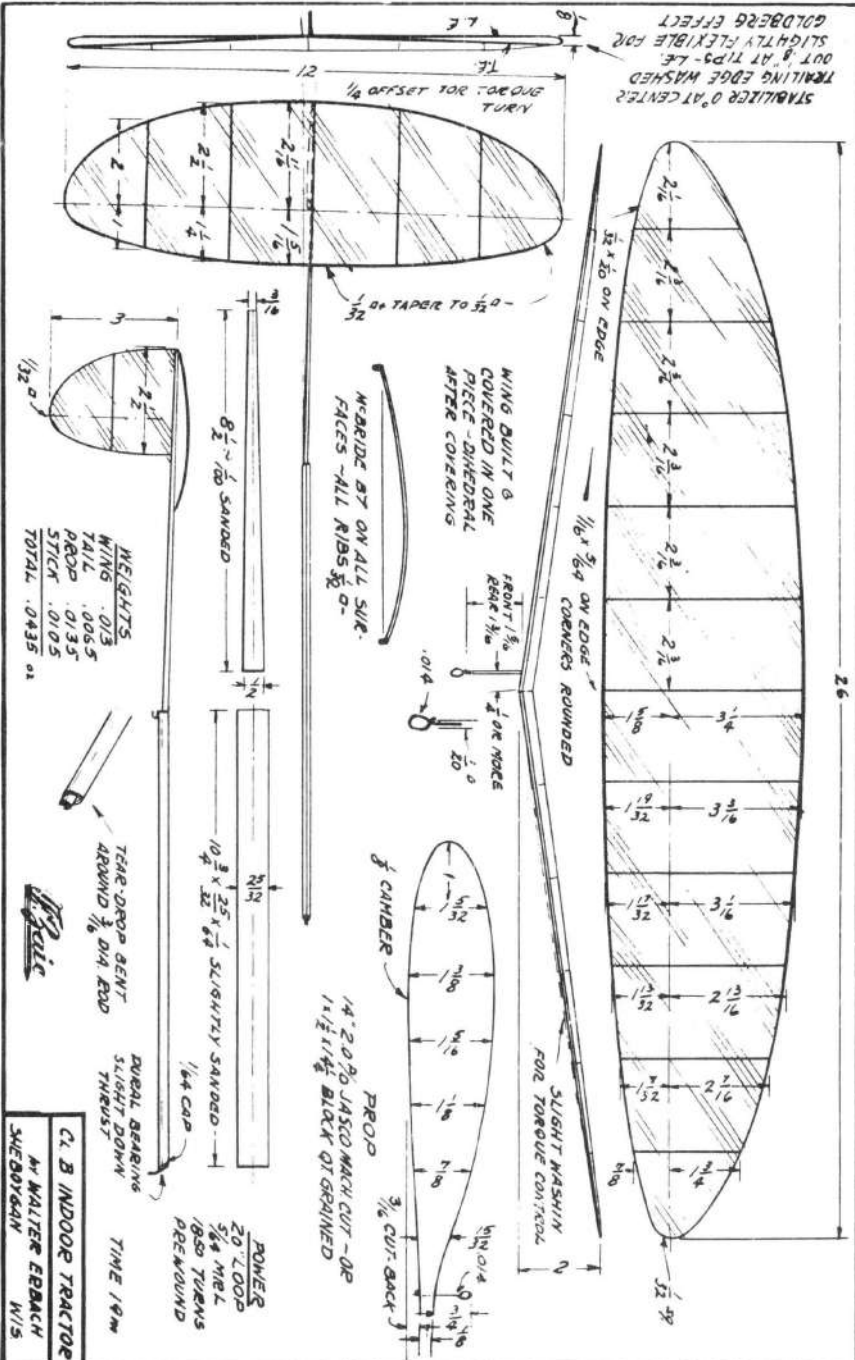
WARRIDE BY ~ RIBS 10 11 59

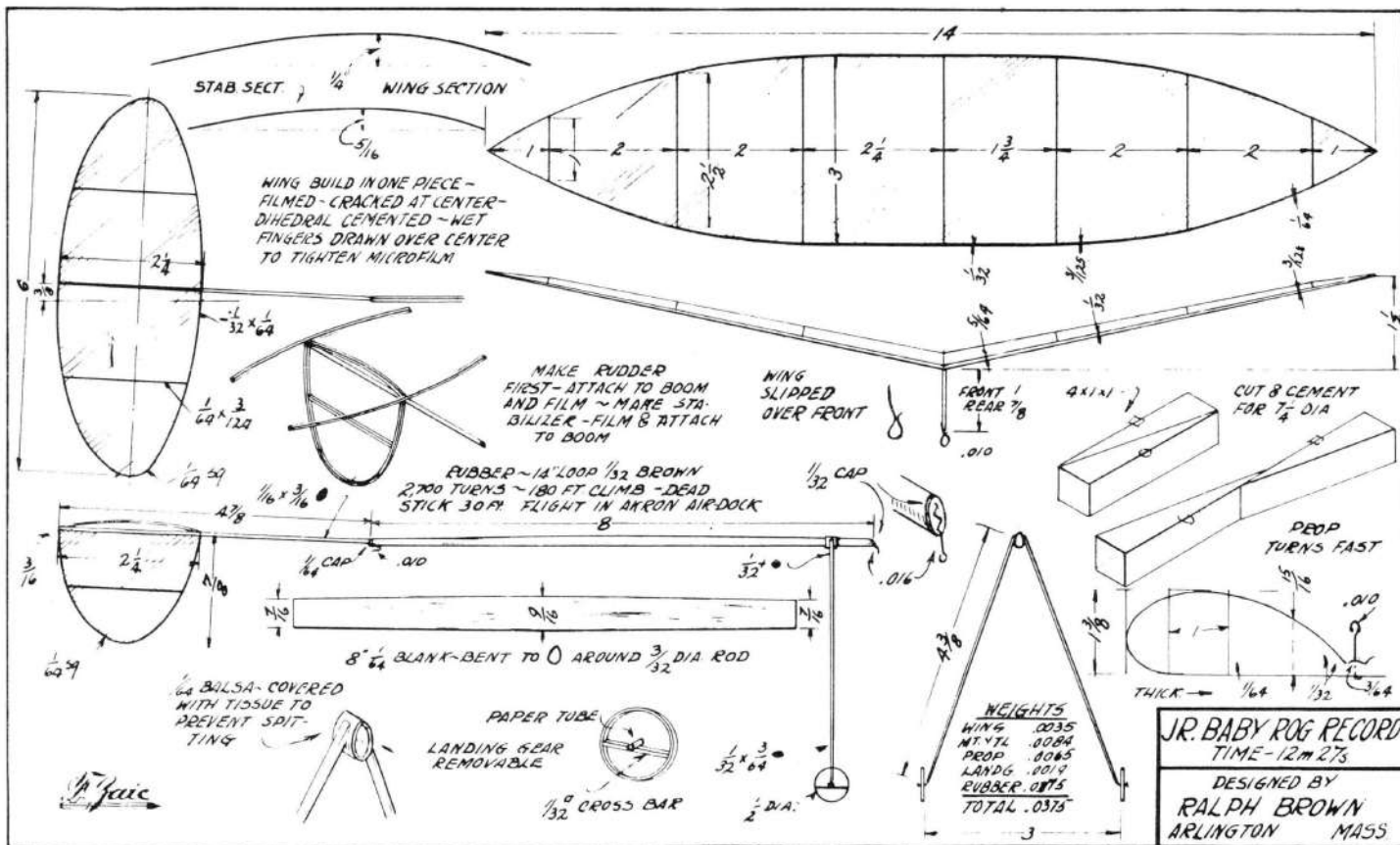
$12\pi^2 \times \frac{1}{64}$ SLIGHTLY SANDED BLANK

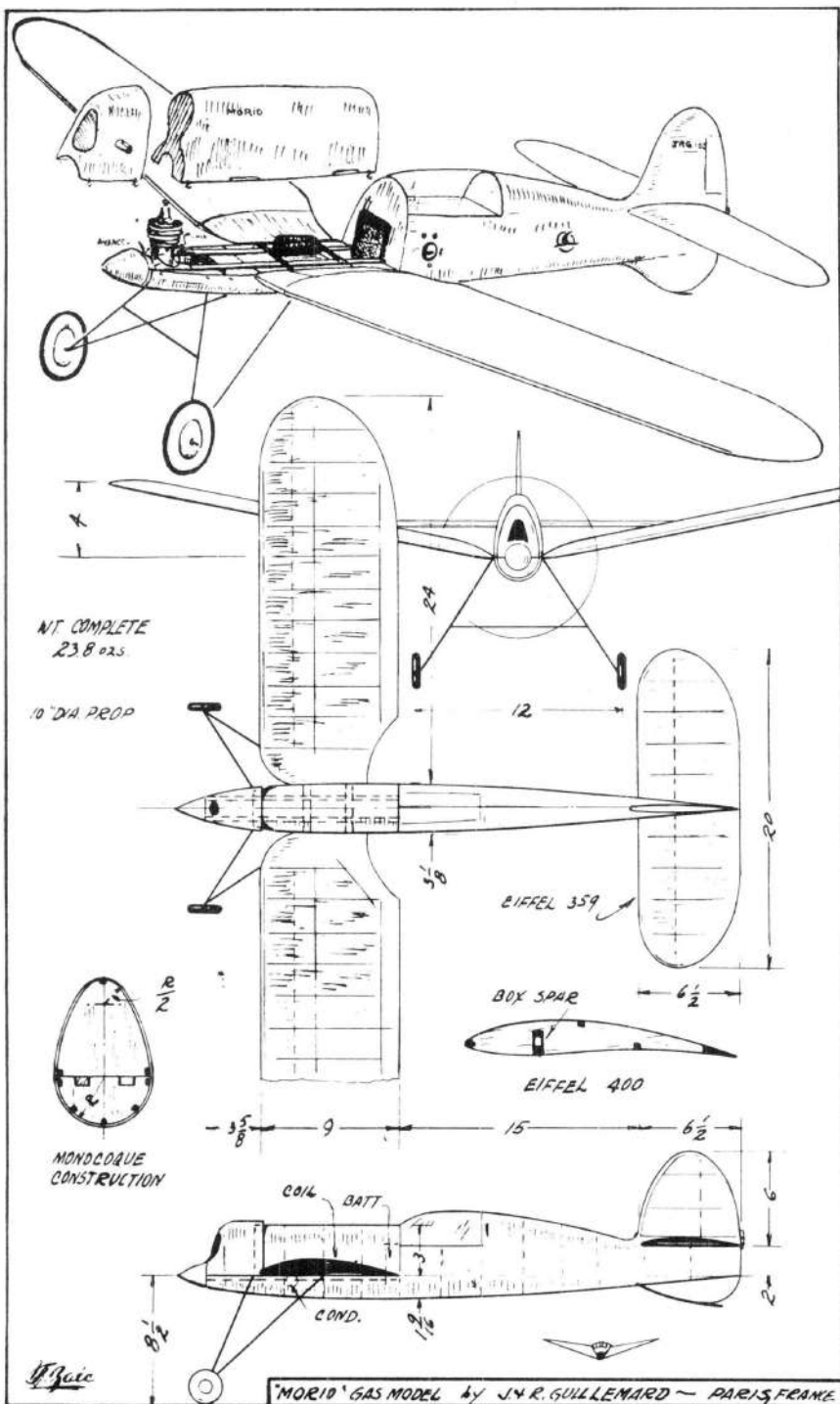
5" 100

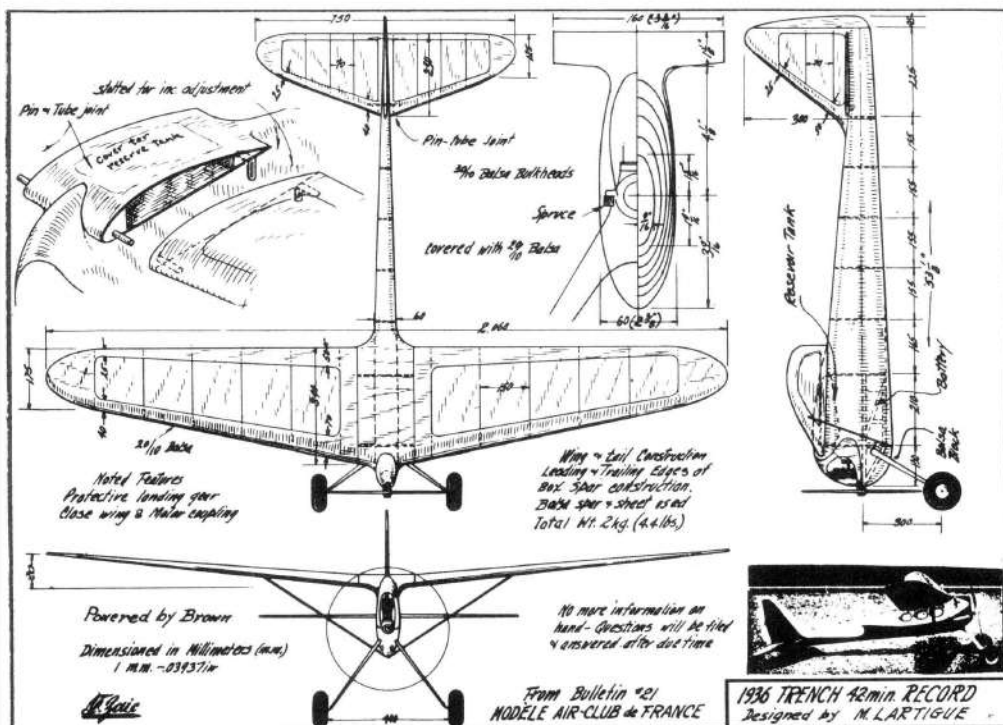
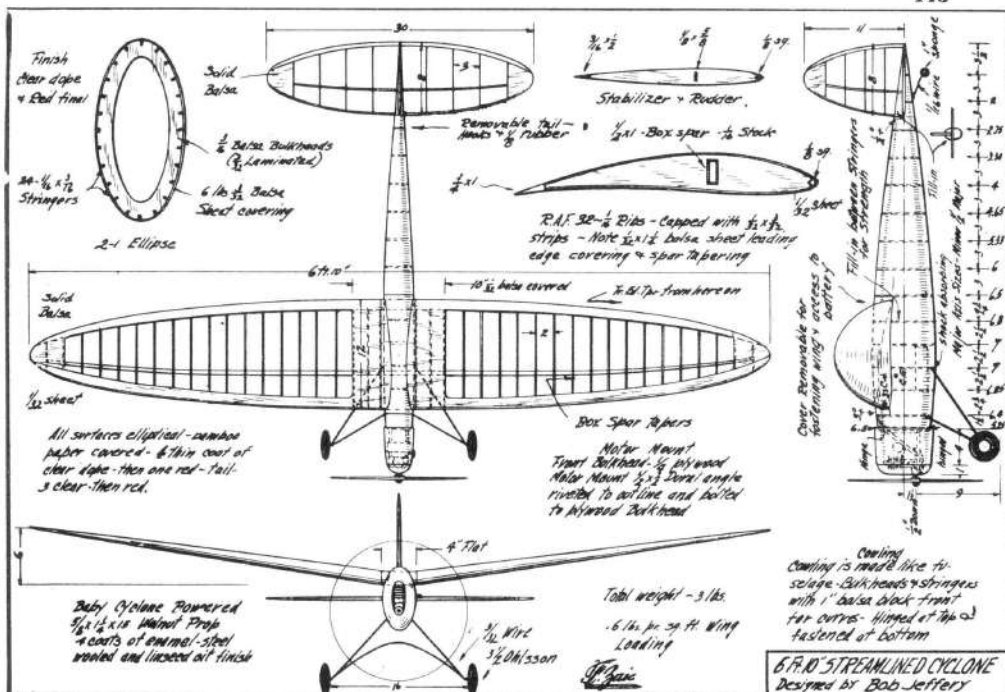
POINT 2 1/2
REAR 25

10









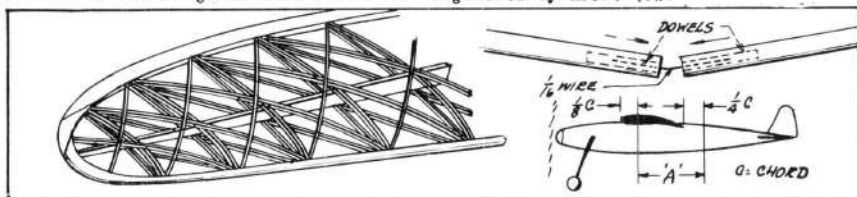
1936 TRENCH 42min. RECORD
Designed by M. LARTIGUE

GEODETIC CONSTRUCTION

by Roy Marquardt

Two years ago British Enginners brought a sensational new development in aircraft construction --geodetic or surface construction. By it's use much longer and more efficient wings could be used with still a weight saving. Altho some work has been done along model lines (see 1937 Year Book) model builder have been slow to take advantage of the things this now construction has to offer. Model results do not seem to indicate that longer wings are advantageous. However, a distinct weight saving are easily made, both indoor and outdoor. The indoor design shown in this edition has the wing and tail weighing only about $\frac{2}{3}$ rd as much as the lightest similar model the writer has used successfully and yet the wings show not the slightest sign of washing out in dives or under power. A microfilm prop so constructed is as stiff as a solid prop of twice its weight. A round fuseage has been turned out using this type of construction around a solid form. The weight was low but so far the construction is difficult.

Geodetic construction is especially effective outdoors. Excellent rubber power wings have been made and a gas job is under construction. The best method is to use ribs cut as top and bottom strips with a template from sheet balsa. With a tapered wing simply cut ribs from the rear to size. Place ribs same as on the indoor model. Use a single thin spar the same height as the rib. Use standard leading and trailing edge. With a light wing, cover the leading edge only with sheet balsa. On a weight rule job the entire wing may be covered and still the wing will not weigh more than the usual type. In plotting ribs the horizontal ordinates of the diagonal ribs should be lengthened by about 40%.



SOME OF MY FINDINGS

by William W. Saunders

DIHEDRAL----Too much dihedral makes a plane rock back and forth, and too little makes it spiral dive or take too long to recover from a side slip. For this reason in recent years I have made all my planes with adjustable dihedral. For rubber band models it consists in taking $\frac{3}{16}$ " birch dowels and drilling the ends to take a $\frac{1}{16}$ " music wire. The dowels (2 to each wing located at approx. 30% and 70% of the Chord) are glued in the wing at the root. The dowels need not be any longer than about $1\frac{1}{2}$ ". The $\frac{1}{16}$ " wire is bent to the desired dihedral. Such a plane is very flexible and practically crash proof.

C.G.----I found that the C.G. can be located within the "A" dimension shown in the sketch and be stable depending upon the size of the stabilizer. The larger the stab, the further to the rear the C.G. can be located. With the C.G. at the furthest forward position, the plane will have the poorest glide but the most stability in very rough weather. As the C.G. is moved toward the rear, the stab becomes a lifting tail and the plane squashes out of stalls and has that floating characteristics. I have found the C.G. location to be independent of the location of the wing above or below the body. A low wing Plane will definitely fly with a lifting tail. Since a low wing plane does not have the pendulum stability of a high wing plane the stab. must do a little more of the correcting of stalls and therefore the C.G. is moved forward.

VERTICAL POSITION OF WING---- I have had my best luck with mid-wing planes. High wing planes require too much down thrust. Strange as it seems I have found that low wing planes require more down thrust than high wing planes. I dislike downthrust because it is the same as adding weight to the nose of the plane when under power. I do not think that a down thrust plane flies along it's thrust line. My wings are always placed on the body at the best L/D.

AIRFOILS----For rubber models modify a RAF-32 by reducing the upper camber 20%. For tail surfaces whether lifting or non-lifting use a thick section. I always use a M-6. When the plane starts to stall the tail snaps up in place and the plane does not lose altitude. Take advantage of the late stalling angles of thick tail sections.

TAIL SURFACES ---- The larger the stabilizer the greater the stability and flatter the glide. I use stab. on rubber models about 40% of wing area and for gas jobs about 30%. A plane will fly in a calm with a stab equal to 15% of wing but keep the C.G. well forward. The glide will be poor. The fin area is independent of the stab. area. Keep it small --about 13% of the wing for rubber models and 8% for gas models.

FORMULAE FOR CALCULATING MODEL AIRPLANES

By ARVID PALMGREN

The following formulae are approximately valid for single skein rubber powered model airplanes of standard design.

SYMBOLS

R : rubber skein sectio, sqmm	D : Propeller Diameter, cm
W : total weight of model, gr	B : max. propeller blade width, cm
S : Span of main wing, cm	v : model flying speed, m per sec.
M : motor torque, mmgr	q : specific main wing loading, gr per sqdm
n : propeller speed, r.p.m.	N : number of winding turns
s : propeller slip, %	L : original skein length, cm
T : propeller thrust, gr	C : total rubber weight, gr
P : propeller pitch, cm	(spec. gravity : 0.9)

Recommended maximum rubber section ---- $R = 0.1 \sqrt[3]{(WS)^2}$ sqmm

(Conversion for 1/30" Gage---1/8 = 2.7 sqmm 3/16 = 4.0 sqmm 1/4 = 5.4 sqmm)

Rubber torque ----- $M_{\text{mean}} = 9 \sqrt{R^3}$ mmgr ----- $M_{\text{max}} = 27 \sqrt{R^3}$ mmgr

(Valid for 30 R 90 sqmm Black Rubber and recommended degree of winding)

Propeller Speed ---- $n = 47000 \sqrt{\frac{M}{PBD^3}}$ r.p.m.

Propeller Thrust (assumed) ---- $T = 0.13 \frac{M}{P} \sqrt[3]{s - 10}$ gr

(s = 15% at M_{mean} --- 52% at M_{max})

Model flying speed (minimum horizontal speed) $v = 1.5 \sqrt{q}$ m per sec.

Winding turns (black rubber) $N_{\text{first}} = 65 \frac{L}{\sqrt{R}}$ $N_{\text{final}} = 80 \frac{L}{\sqrt{R}}$

Propeller Pitch----- (for max. altitude): $P_{\text{min}} = 12 \frac{R^3}{W}$

(for good altitude): $P_{\text{mean}} = 18 \frac{R^3}{W}$ cm (for moderate altitude): $P_{\text{max}} = 24 \frac{R^3}{W}$

(P_{max} to be used for handlaunched models only)

Propeller Diameter:--- $D = 5.7 \sqrt[3]{\frac{P \sqrt{R^3}}{q B}}$ cm

Maximum Altitude (above starting point) and flight duration (no vertical wind)

Propeller	Maximum altitude in meters	Motor time in seconds	Total time; sec. freewheel prop	Total time in seconds Ret.Ld.Gr. & Free prop.
P_{min}	$175 \frac{C}{W}$	$600 \frac{C}{W q}$	$1400 \frac{C}{W q}$	$1800 \frac{C}{W q}$
P_{mean}	$130 \frac{C}{W}$	$900 \frac{C}{W q}$	$1525 \frac{C}{W q}$	$1850 \frac{C}{W q}$
P_{max}	$105 \frac{C}{W}$	$1200 \frac{C}{W q}$	$1650 \frac{C}{W q}$	$1900 \frac{C}{W q}$

EXTRACTS FROM CORRESPONDENCE RECEIVED

from Henry Stiglmeier

After making a long list of data gathered from flight experimenting on various wing sections, the comment was: "Power - variable, weather - variable, adjustments variable, effort- too much, no fun.---Now I think that almost any airfoil will ride thermals. However, the glide seemed to be more affected by the airfoil than the climb."

"I tried a feathering prop with large blades on a stick model. After the blades feathered the tail of the model would swing from side to side on the glide. I tried the same prop on a cabin model which flew well but trouble was again experienced in tail swinging. I increased the rudder area but it did not help. Next I found that if the prop was given a chance to freewheel, it would do so rather than feather until the speed of the model was slowed down very much at some time during the flight. Usually if the model stalled slightly the blades would feather and then the plane would weave sideway or stall depending on whether the prop stopped vertically or horizontally, respectively. Later I made tests on of the drag of the feathering prop by putting it on a shaft with a weak spring behind it and then running into the wind. I would start with the prop feathered and when I gained enough speed, the prop would suddenly begin to freewheel and continue until I slowed down to a walk. When the prop was freewheeling the compression on the spring was about twice as much as that of feathering position."

"Harry Johnson tried a number of different % stabilizers, while I tried the airfoils on my stick. General impressions gained from the tests was that 45% tail area gives best results for stick models and about 40% for cabin jobs. We also reduced the size of our props for the increase in weight rule.--I've learned a few things about rubber tensioners. The spring must not be too weak the stop arm must really be soldered to the shaft, and there must be plenty of clearance around the motor for large knots.--If a tow line glider tows up with side diving tendencies, place the hook on the side of the fuselage opposite the tendency and the glider will make a straight up tow."

GAS MODELS

"The winning model had a crank thru the fuselage with cords fastened to short heavy rubber, which was fastened to the wing. He cranked until the wing was held on tight.---The best position of the wheels on small gas jobs is about half way between the prop and leading edge of the wing. This position prevents the tail from banging to the ground and it improves the taxing ability of the model very much. Broken props from nosing over the grass are rare.---The size of the fin on high powered gas models is very important for good flights. About 72% of the wing area is the best to start with. The area should be changed if necessary after flight tests have been made.---Tempered dural is very good for engine mounts, however, plain aluminum or soft dural mounts crack before long from vibrations."

TWIN ENGINED GAS MODELS

"The original idea in mind for flying a twin engined model, which was made by my brother, was to set the thrust line of each motor so that it would counteract its off-center turning moment. If each engine could be separately adjusted to fly the model by itself, then it would not be necessary to synchronize the engines. However, in practice the idea did not work so well. Either engine, with the other dead, would fly the ship but even with a large outward slant of the thrust line, the plane could not be made to fly the same way. Then we obtained an engine ignition circuit which would keep the engines synchronized. Also, if one engine stopped, the other would also. This special circuit did operate but then we experienced considerable trouble in getting the engines perfectly synchronized and also to prevent both engines from stopping. About four flights of short duration were made with the engines running on the special circuit and about ten flights on regular circuit. On two occasions one engine stopped and the plane flew in tight circles and lost altitude until it struck the ground. However, slight damage resulted. In summing up, the trouble encountered in trying to synchronize the two engines and the two fold possibility of engine trouble made this particular arrangement of engines undesirable."

WINGS

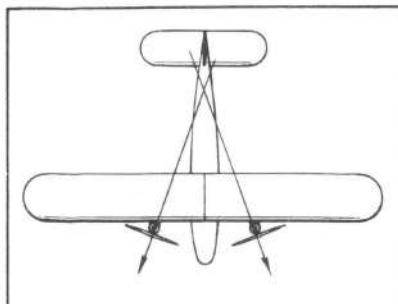
by Dick Everett

During last summer and fall I made many experiments with wings. I found that Aspect Ratio does not matter but it is more to the liking of a model builder. All I can say is that whoever said that a low Aspect Ratio wing is better than a high Aspect Ratio wing never took time to build and try a good Aspect Ratio that was fairly high (18-1). And also, whoever said that Low Aspect ratio is poor never took time to build a good low Aspect Ratio wing. Now these are very strong statements. But I have really gone to extremes by building wings of 3-1 and some of 18-1 Aspect Ratio. I have tested models with medium ratios (6-1, 9-1 and 12-1). The extremes climbed and glided better than those commonly used. If one makes wings with identical wing loading, Aspect Ratio does not seem to matter as long as you use a good airfoil (RAF-32 can't be beat). It would seem that Aspect Ratio is a matter of preference rather than practicability.

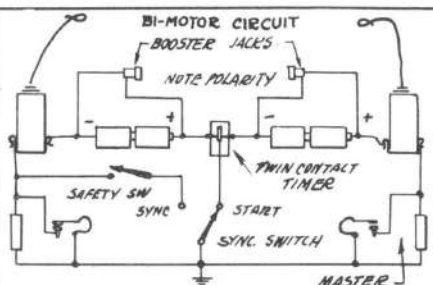
If someone would publish full size airfoils instead of ordinates, I think that better times could be made. It takes an expert draftsman to draw an exact airfoil. I also think that it would be a good idea if the balancing point is given when plans are drawn. This would give the builder a much better chance to duplicate the model in all respects.

Wing construction varies with individuals. Cleveland fellows use the multi-spar type and they get some wonderful flights but breakage is very high. Some of their wings have small braces on top of the airfoil to keep the wing from folding up. (I realize that in New York your models last for years and years. However in CLEVELAND we usually lose our models on the second or third flight.-- from Jim Ryan letter, ED.) Another design is the single spar type which is good in having low breakage. But did you ever notice the sag between the ribs? Then we have balsa sheet covered leading edge with full depth spar. This is strong but the sag behind the spar ruins the airfoil section. A type I developed is to build a skeleton wing of two spars and leading edge, space ribs 3" apart, cover top with sheet balsa, and cement 1/32 x 1/16 ribs every 1" on the bottom which is covered with paper. Of course all balsa covered would be best.

A small streamline section mount seems to be the best means for fixing the wing to the fuselage. The mount can either be fixed to wing or fuselage, or free from both. If this type of wing mount is used the dihedral can be decreased to 1" for every foot of span. While a wing-on-fuselage needs at least 1 1/4" per ft of span under each tip. I prefer the tip type of dihedral as it seems that the model is stable with less dihedral and at the same time the flat center section give full lift. --- When adjusting plane never warp the wing unless it is absolutely necessary. Warpage will weaken the the wing as well as jam up the glide.



BASIC CIRCUIT-NOTE 6VOLTS



START AS SHOWN - BRING MOTORS INTO STEP WITH SPARK CONTROL - SNAP SYNC SW. TO 'SYNC' - IF MOTORS ARE IN STEP, THEY WILL LOCK IN AND RUN IN SYNCHRONISM - THEN THROW SAFETY SW. BEFORE FLYING - ONLY ONE TIMER USED THEN - USE MOTORS NEARLY MATCHED - USE POOREST MOTOR FOR MASTER - USE HEAVY WIRE - (CIRCUIT - WITH SYNC SW. AS SHOWN, MOTORS ARE INDIVIDUAL - SYNC SW. OFF, THE CIRCUIT IS A SERIES AS SHOWN IN BASIC - 6V. IN SERIES WITH TWO COILS - 3V. TO EACH END - NOTE POLARITY)

DESIGNED BY NATHAN R. SMITH MFG. CO.

THE IMPORTANCE OF STREAMLINING GASOLINE MODELS

by Carroll P. Krupp

A group of young men from Akron, Ohio, under the able guidance of Mr. George Evans, of the Goodyear Zeppelin Corp., went into the subject of streamlining gasoline models in the spring of 1936, and as a result several wind tunnel tests were made on gasoline model fuselages and landing gears. Although the work was never completed, sufficient information was gained to prove that streamlining would not only help but would be of the utmost importance in the future development of gasoline models.

The necessity for keeping down the drag of a model airplane is evident, although the means of accomplishing this end is not at all obvious. What little is known about streamlining has been learned from long experience, for knowledge of the subject is still so incomplete that no scientific system or theory about it exist as yet.

Before the various charts and graphs are discussed, one should first have a clear idea of what drag (Parasitic" drag) is, and what terms it is measured and calculated. To save space and time the explanation of drag and its measurements is given in short statements rather than as a complete discussion. It has been found that air resistance may be reduced to a minimum by streamlining, which means that the shape of all parts of an airplane exposed to the air stream are moulded so as to permit the air to flow around them with the least amount of resistance.

Information concerning "Parasitic" drag has been gathered through tests in wind tunnels and by practical experience. The drag of the component parts of an airplane as given in aeronautical handbook is given in their drag areas or in the form of their drag coefficients.

1. Drag area is defined as the area having a drag coefficient of 1, and the same resistance as the part to which the coefficient applies. It is computed by the following formula: $\text{Drag} = .00256 (\text{drag area}) \times (\text{velocity})^2$.

2. The equivalent flat plate area is the area of a circular plate at right angles to the airstream having the drag equal to that of the parts compared.

(Drag area and the equivalent flat plate area must not be confused because the drag coefficient of a flat plate is greater than 1. It is 1.28; Hence: $\text{Drag Area} = 1.28 (\text{equivalent flat plate area})$.)

3. The drag coefficient is computed by dividing the drag area by the cross section of the object, at right angles to the path of motion.

RESULTS OF WIND TUNNEL TESTS

The group mentioned in the beginning of the article planned to make complete drag tests of the component parts of gasoline models and the effect of streamlining the fuselage, landing gear, struts, control surfaces and motors. The results of the tests ran at the Guggenheim Airship Institute at the Akron Airport are presented in this article.

Two types of fuselage were used in these tests. Ship A -- a simple fuselage with no fairing on the motor or landing gear. Ship B -- a fuselage with the nose rounded off to a fair degree, and the motor cowed, except for the cylinder, timer arm and carburetor. Both fuselage were of rectangular cross section and had 1/8 dia. wire landing gear. Ship A had 4 x 3/4 wooden wheels. Ship B had 3 1/2" M & M airwheels.

Fig. 1. Gives the relative shapes of the models tested.

Fig. 2. Is a graphic illustration of the drag found in terms of equivalent flat plate area, in both square centimeters and in square inches, of the A & B models with and without landing gear and wheels.

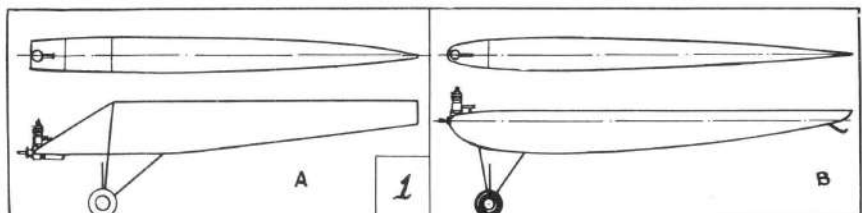
Fig. 3. Is also a graph of the drag found for the two models with and without landing gear and wheels as given in the actual amount recorded in the instrument in grams at various speeds.

If one looks over these various charts you can get a good idea of what a little streamlining will do for the reduction of drag. The comparison of A and B

in Fig. 3 should be proof enough that streamlining is a sure step in the right direction. At the speed of 24 m.p.h. the ship "B" has only 1/2 the drag of ship A. From these graphs we also see that the landing gear and wheels constitute about 1/2 of the total fuselage drag and that the wheels alone produce about 1/2 of that amount.

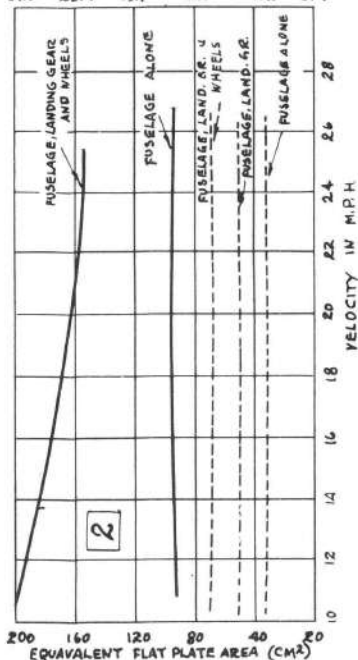
When we consider that the "Parasitic" drag of an airplane is very near to 90% of the total drag and when this is thought of in terms of power required to overcome this resistance one begins to wonder and worry; for the climbing ability of an airplane is proportional to the available horsepower divided by the weight. Since this available horsepower, (which is the amount in excess to that which is required to sustain the airplane in level flight) as equal to the product of the total drag of the airplane and the velocity at which it flies divided by a constant, that is, $\frac{D \times V}{550} = \text{The Available Horsepower}$. It places direct bearing on the importance of the reduction of drag on gasoline models, to increase the climbing ability as well as other flight characteristics.

There are many ways in which gasoline models may be "cleaned up" and their performance materially improved. By the streamlining of the landing gear or possibly the elimination of it in favor of a wheel protruding from the bottom of the fuselage, the total drag of a gasoline model may be reduced by as much as 40 or 50%. General improvement in gasoline model design is not far off as the "fever stage" is over now and the model builders are trying to improve their design and consequently their performance; and not being satisfied to merely "turn out" models.



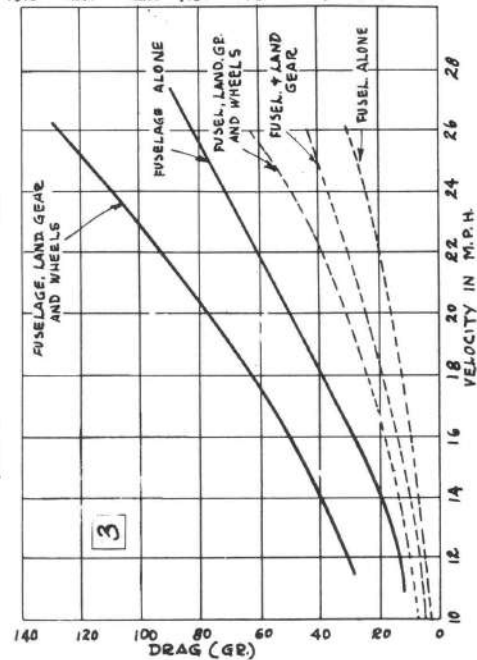
EQUVALENT FLAT PLATE AREA (sq.in.)

31.7 25.4 19.1 12.7 6.32 3.17



DRAG (lbs.)

.316 .271 .225 .180 .135 .09 .045 0



GAS JOBS a l'ANGLAISE

by L.S.Wigdor

In England there are two schools of thought in the gas job world, of which I represent but one. I mean that half the enthusiasts build their machines of spruce while other, including myself, use only balsa. Personally, I am fed up with hardwood construction inasmuch as it entails so much work, whereas I find that balsa is so much easier to use, as well as being just as strong.

We have a vastly different problem to face here in our design of gas jobs, due to many reasons. The main thing is that we have no wide open spaces to fly our jobs, and on account of this, you find that the designer of an English gas job considers flight characteristics a more important thing than duration. He would much rather see his machine do a flight of one minute, in the course of which it did a perfect takeoff, good glide and a stable landing, than see it just climb into the blue finally disappearing over the skyline. The quest for more stability is the most important object in the design of the modern gas model, whether it be American or British, and I think that here in England, this holds good in the majority of cases. One interesting point arises here: Spiral Stability is not taken of much account in England due to the fact that crashes so caused are not frequent. This is because we fly our jobs at much lower thro-tles than do you Americans. However, the toll comes when a high wind is blowing and no doubt we will improve on this matter. I have taken some pains to make "Firebird" stable on turns by dropping the rudder area, with good results.

The average English gas job is stronger than the American because we have to build them to stand up to the very bad weather conditions we fly under. Consequently the wing loadings are higher but as we fly them at their slower speeds, the climb is not so good. This does not hold for all operators, some of whom like a little speed. One enthusiast I know, Mr. Trevithick has a machine that has a loading of 24 ounces to the square foot. This machine flies at about 25 m.p.h. and has made over 250 successful flights. The wing span is 5 feet and the motor is a Brown Jr. It is one of the most consistent flyers I know. This machine is an excellent example of the contrast there is to be found between American and British models. You must not take me as being typical of the majority of English enthusiasts; I am not, but I think that balsa is becoming the more used material in gas jobs over here, just as it has conquered the elastic models.

You will notice that I have a very wide undercarriage on the "Firebird", and this brings the machine in properly every time. This is very important in the type of contest we have over here as well as being a safeguard to the machine. Unassisted take offs are required in our contests, and if you have an inefficient undercarriage, much difficulty will be had in preventing ground loops. The all wire type is used has proved itself to me to be most reliable one under all conditions.

One of the most outstanding features of the British gas job, is that time switches have always been fitted, even from the pioneer days ten years ago. Nowadays, the S.M.A.E. have made it one of their rules that all models in England have such fitted, and they have earnestly advised every enthusiast to procure a third party insurance to safeguard themselves as well as well meaning onlookers. When we fly our models, we only send them up, at the longest with a 90 second engine run. As for myself I have never had a model in the air for more than 4 minutes, and I've been flying gas jobs for three years. I don't see the point of longer flights, unless its to prove that one model has a better glide, and more aptitude in finding thermals than another. I think that this is the general view that we have over here. We are very unfortunate however, in that we have but two contests a year and thus builders are not encouraged to improve the efficiency of their models. If it were not for the fact that the enthusiast here is a much older man, we would have no progress at all. I am in the process of working out a new contest formula which I hope will give every model a good chance. It will be a timer contest, the time of engine run depending on the all up weight, the engine capacity, and the wing loading. Three flights will be had, the total duration counting, while points

will be given for landings, and takeoffs. All timers will have to be calibrated, and stopwatch time will be taken of the actual time of engine run in the air. The duration will be corrected for over or under run of engine. I hope that this type of contest will tend to make the builder get the best out of his engine as well as making him design a better aeroplane. I think it is a poor policy to judge a contest for design of models as the only true test is had when it is flying.

The outstanding factors of British construction practice can be summed up as follows:-

- a. The need for greater strength entails the use of harder woods.
- b. Bigger and stronger undercarriages.
- c. Removable motor units, tail units and wings.
- d. Less use of balsa for covering, and the universal adoption of silk.
- e. A greater tendency to fixed center sections, with removable panels

As to aerodynamic design:-

- a. The use of higher wing loadings, with more powerful engines run at lower throttle, is common.
- b. Many builders use home designed wing sections much deeper than even the K.G. gas job section
- c. Machines are rarely smaller than 7 foot wing span.
- d. As in the U.S.A. high wings predominate, but parasols are few, most machines being cabin jobs.

On the whole, the English gas job is a very consistent flyer, and has not the lively performance of its transatlantic brother. Safety and reliability under all conditions, is the aim and end to which we strive.

CONSTRUCTION OF THE FLYING WING

By Tex Rickard

The flying wing is to be the Airplane of Tomorrow as we gather from the articles of Hall Hibbard of the Lockheed Co. and Donald Douglas of the Douglas Co. I had been working on the idea few months before any articles appeared and I think that I have some better ideas on the subject or improvements at any rate.

The Flying Wing can be built very cheap and on the one that I designed, a Husky Jr. motor was used. The main wing has an area of 159 sq.in. and is large to carry a Cyclone or a Gwin, or midget motor. My plane weighs 1 lb and to carry a Cyclone or a Gwin, or midget motor, My plane weighs 1 1/2 lbs. ready to fly and it is built strong.

This model has been flown. On the first attempt it was nose heavy and it hedge-hopped along the ground for about 400 feet before it could be caught. This model cannot be crashed very easily and there will not be any broken prop or rudder as the motor be smashed in a crash. The plane can turn over and the motor will continue to run until the gas is out of the crankcase.

I like the rudders on the wing inside of the stabilizers because the wind cannot slip outward and the stabilizers will get fresh undisturbed air. Where the flippers are in the trailing edge of the wing you lose the lift of the wing at that point. I used a Gottingen 387 section on the wing. The leading edge is covered to one-third back with 1/16" sheet balsa and the whole model is then covered with bamboo paper.

There have been two good flights out of the model in four attempts. It has just been finished and I have not had time to make any more, before writing this.

(Plan of Model on Page 64)

RADIO CONTROL

The thought of Radio Control is old; the actual development work is in its second year. Fair results have been produced by those who know something about remote control by radio. It was done by sweat of the brow since the requirements are mighty tough, and most of the work is of experimental nature. It is a specialized field into which very few radio technicians stray, so that even radio engineers are in quandry about the exact specifications. So, until the radio end is perfected for commercial distribution the average model builder can only dream of the possibilities. But if you want to be one of the early birds in this field get into the amateur radio game. It is a mighty fine hobby. Our only fear is that you will desert the model field. But we will take our chances since you will undoubtedly combine the two and give us the perfect radio control.

Mr. Ross A. Hull, associate editor of QST, is undoubtedly one of the most systematic experimenter in this field. He has been successful in controlling a large model sailplane, not once but time after time. Quoting from his article in Oct. 1937 issue of QST: "Casual glance at the problem would lead anyone to imagine that it is all a perfectly simple business. All one needs is some sort of receiver that produces enough change in the plate current of an output tube to operate a relay of some kind, the relay then being connected to a control device which produces the necessary effect. Closer examination, however, reveals a host of problems which are juicy morsels for any experimentally inclined man. ---Our only hope is to open the subject wide in knowledge that a few hundred of us hammering at the same objective will have the problem really licked in short time." The receiver and rudder control which did the trick on the sailplane are shown. We strongly recommend that you obtain this issue of the QST. If you have a slightest thought of working on the radio control, or if you wish to know just makes a radio tick, government regulations on transmitting and licensing, and construction of receivers and transmitters, obtain a copy of the RADIO AMATEUR'S HANDBOOK from American Radio Relay League, West Hartford, Conn. Price \$1.00 P.

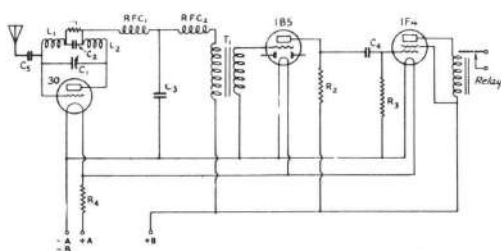
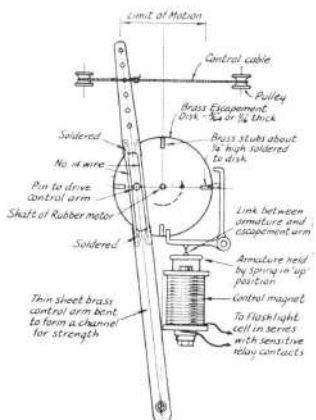


FIG. 3—THE CIRCUIT OF THE PREFERRED RECEIVER

- C₁—17.5- μ f. midjet variable (Hammarlund HF-15).
 C₂—100- μ f. fixed condenser.
 C₃—0.01- μ f. fixed mica.
 C₄—0.01- μ f. fixed paper.
 C₅—M-30 National mica padding condenser, with the upper plate bent at right angle to the lower.
 R₁—1 or 2-megohm grid leak.
 R₂—150,000-ohm, $\frac{1}{2}$ -watt fixed resistor.
 R₃—2-megohm, $\frac{1}{2}$ -watt fixed resistor.
 R₄—500-ohm fixed resistor.
 RFC₁—Ohmite w.h.f. choke.
 RFC₂—Buhl 125 millihenry choke.
 L₁, L₂—Each 4 turns No. 14 wire, $\frac{1}{2}$ -inch diameter.
 T₁—Any very small audio transformer. The one originally used is a push-pull affair with the whole second ary used.
 The relay is an Eby Type ER12 with a 5000-ohm winding.



THE EXPERIMENTAL ESCAPEMENT USED TO CONVERT THE RUBBER-BAND MOTOR TORQUE INTO RUDDER MOTIONS

RADIO CONTROL FOR MODEL PLANES

by John S. Lopus W8LUZ

There have been many systems of radio control built for use in model planes. Most of them are simple and inexpensive, in fact they are too simple. Due to this the writer has made an attempt to build a system which is not necessarily simple but embodies the features which a good control system should have. These good features consist of two things, flexibility and rapid control action.

To achieve flexibility one must be able to operate three control; elevator, rudder and motor. With these controls one can do most of the plane maneuvers. Each control must be able to move instantly either side of neutral,

and also the degree of movement must be under the operator's control. The system developed by writer and which was shown at the 1937 Nationals is still in process of development but it holds promise of being something really different. Since the work is incomplete, only an explanation of the system will be given.

In this system, a tone signal is first generated and impressed upon a radio wave. This wave is picked up by the receiver and the "tone signal" portion fed into the circuit selector which operates the desired motor via relay. The tone generator is of tuning fork variety. This is not too much trouble as each signal generator consists of few parts. The different control signals are obtained by using different generators.

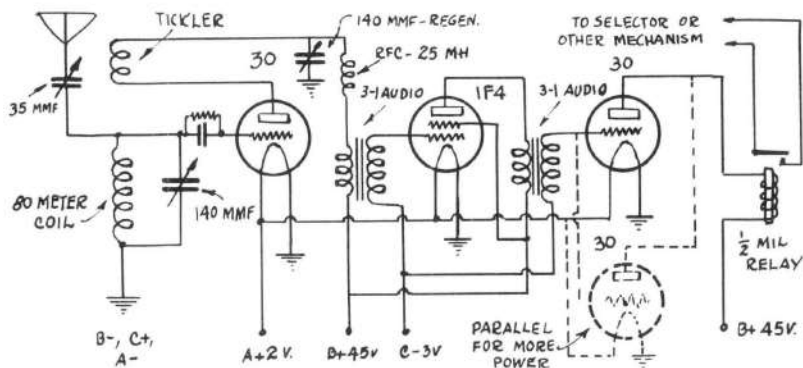
The circuit selector is most important or "brains" of the whole control system. It is of the resonant reed type. In this circuit selector the control signal is fed into a coil which is wound on a transformer core that has an air gap cut into it. Across this air gap there are mounted six steel reeds. The control signal causes a varying magnetic flux across the air gap, which causes all the reeds to vibrate slightly. One of the reeds, however, has the same natural frequency as the control signal and it will vibrate strongly due to resonance. The reed rapidly makes and breaks a contact and acts as a switch which closes a small relay. There are six reeds which control six relay, one for each control function. The controls are operated by small reversible motors which work through worm and gear to push or pull the control rod. When the motor stops the control will stay in position because of the worm and gear combination.

The radio Transmitter is a standard five-meter transreceiver. The control tone signals are fed into the microphone circuit of the transmitter. The complete system used on the plane weighed a little over five pounds. Since then it looks quite likely that the total will not exceed four pounds. This is a very sketchy description of the control system but one can readily see that it has features which are not contained in any other system. For instance, each control can be operated instantly without going through any sequence. This makes for rapid control selection. Also many control signals can be impressed on the same radio wave so that more than one control can be operated at a time.

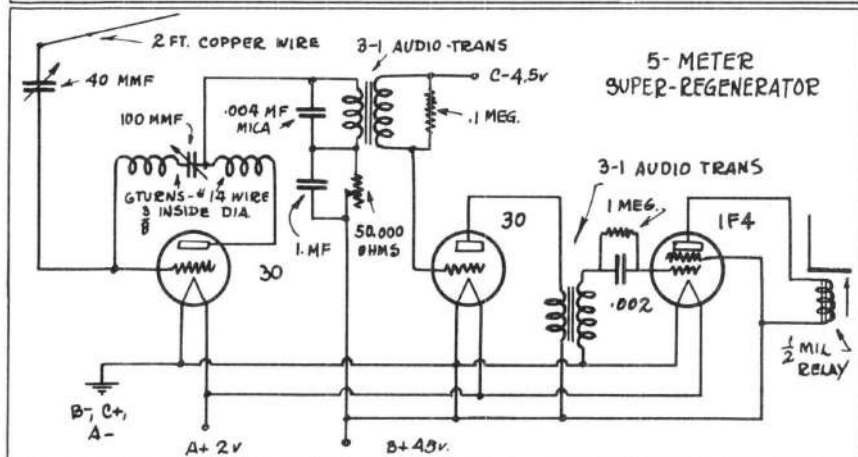
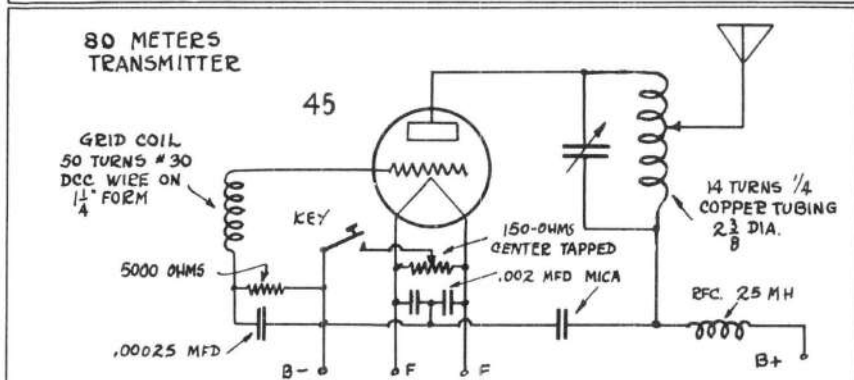
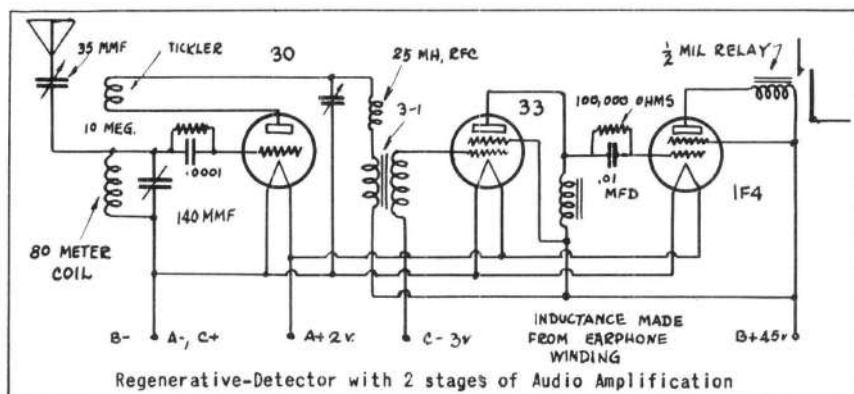
RADIO CONTROL CIRCUITS

By Chester Lanzo

I have drawn a group of different types of radio control apparatus for the experimentally inclined radio control enthusiast. I cannot say which is the best receiver as each has its advantages and disadvantages; experiment alone will tell.



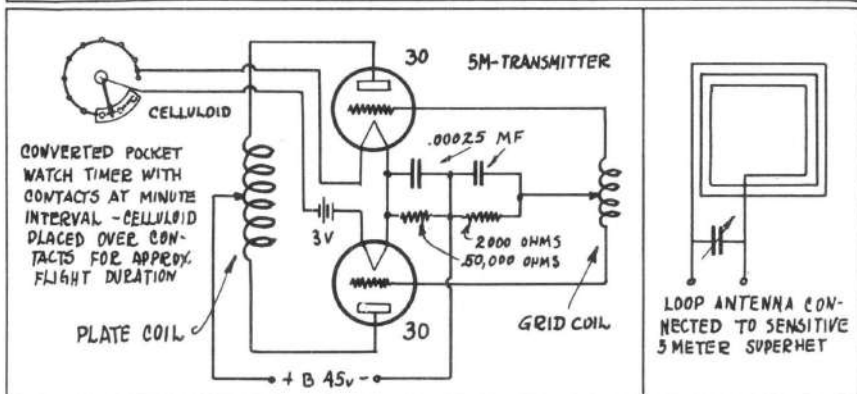
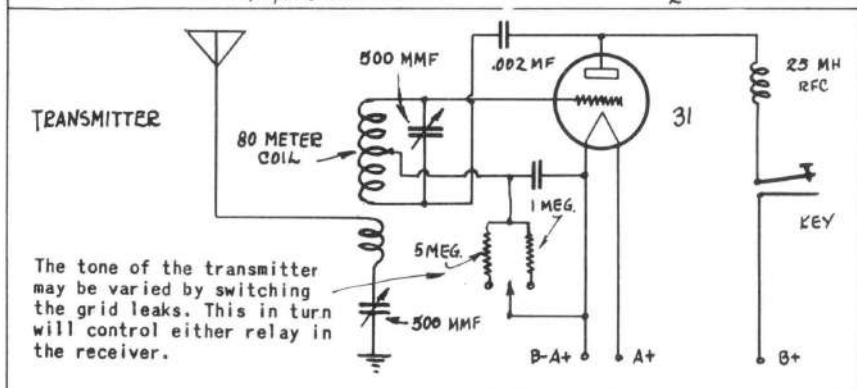
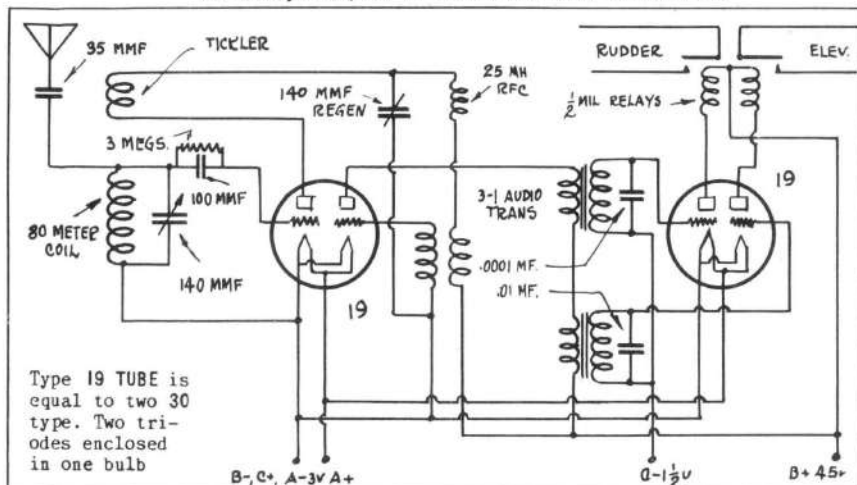
I seem to have most success with this type of receiver using the 80 Meter Band. I will switch to the 160 Meter Band as I think more consistent results will be obtained.



Two types of circuit have proven their worth on the 5 meter band, the superhet and the superregenerative receivers. The superhet requires many tubes and high plate voltage to obtain consistent results. The superregenerator may not equal the results obtained by the superhet but it is a lot easier to construct and operate and it uses few tubes.

Trees, hill and fences decrease or cut off the signal to a great extent. The lower frequency seem to produce a more stable and dependable receiver.

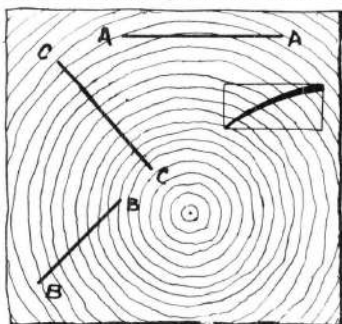
The relays respond to different tones transmitted.



I am working on this device at the present time. The receiver is installed in a car. No more lost gas jobs with this idea. The transmitter can be built to weigh about 10 ounces and is installed in the plane. If after a length of time the model goes out of sight or is lost the transmitter signal is picked up by the loop antenna and the direction in which the model lies is determined. Then the volume of the received signal will tell whether you are approaching or going away from the model.

BALSA WOOD

The climatic conditions under which balsa grows provide an almost uniform texture throughout the log, although a change in the season is definitely marked by an increase or decrease in the rate of growth. However, the degree of change is usually comparatively small so that the texture is fairly uniform. The growth rate determines the strength and texture. A moist set of years will produce fast growth of light but weak balsa. While a dry set of years or high ground will cause a slow growth with consequent heavier and harder balsa. Soft or light balsa is also more likely to be streaked with mineral colors because of the relatively larger pores through which moisture can carry the fine color sediments. This color streaking does not impair the strength since there is no break in the fibers caused by accumulation of foreign material.



tween the two extremes. This cut is most commonly stocked by the model supplies companies. Also note the end of a quartergrained prop block.

These different grain characteristics plus the weight differences of fast or slow growing can be utilized to provide maximum strength with minimum weight if the grain and weights are properly used.

In construction the C-C cut is used for ribs, sides of fuselages, bulkheads, and wherever a stiff but light structure is needed. This grain will have a slight bend under just-about breaking point. Then it will just snap! The A-A cut will take bending very easily. In thin sheets no moisture is needed, while the thick or heavy sheets just need surface or slight wetting. It is mostly used in tubular construction and round covering. Fairly large compound curves may be covered if the wood is perfect and the builder has sufficient patience to work out the curves. The importance of graining lies chiefly in thin sheets up to 1/8 thickness. Strips are also best if the largest dimension has the "C" grain as it will hold up better under buckling or twisting. When dimensions are in proportion of less than 2 to 1 the grain can be of any type as long as it is straight grained.

The poundage of balsa is based on the weight of one cubic foot. 3.5 to 5.5 lbs. is used for indoor models and planking strips. 5.5. to 7.5 lbs. finds excellent use in wings for handlaunched gliders. 7 to 12 lbs. covers the rubber models. The grading is naturally according to the stress imposed on the structure. 9 to 12 seems to be the favorite. 10 lbs. to almost hardwood characteristics fills the gasoline model needs.

Under the present supply system it is difficult to obtain the exact grade needed, but as a rule most companies have some sort of specifications to make selection easier. If the price of balsa was not so low, the above system of grading and graining would be universal, but under the circumstances very few companies are willing to go through the required tedious production procedure. Perhaps some day when most of us become income tax payers the supply industry will get a break.

BALSA WOOD LAMENT

Scratched by tiger's paws,
Crushed by coiling boas,
Crunched in the deep Amazon
By jaws of scaly amphibians,
Torn apart by steely teeth,
Shipped miles over briny deep,

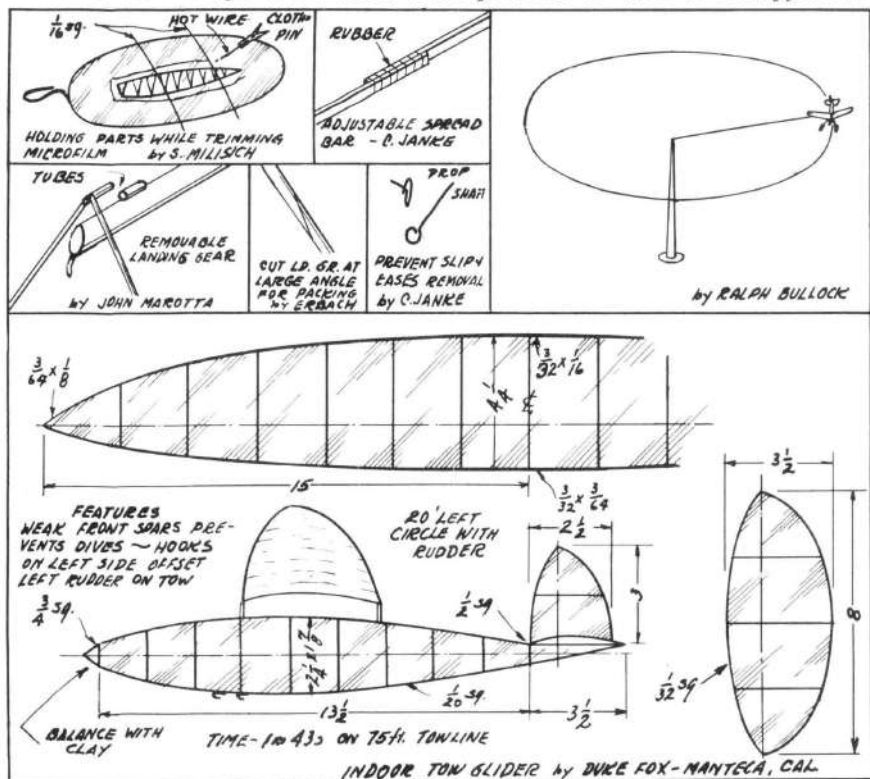
Parched to dryness by terrific heat,
Haggled over by a pair of Scrooges,
Bought by a couple of stooges,
Who turned out to be balsa butchers.
Tis a sad and pitiful end for me
The lightest of the jungle trees!

INDOOR MODELS

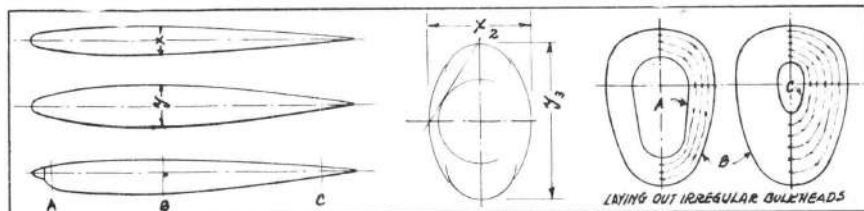
The exciting and pioneering days of indoor model development seemed to have settled down to fixed designs and construction. Contest are won by knowing the ship and having luck to keep clear off the obstructions. At the moment there are no indications that the designs and construction of standard indoor models will be changed for a quite a while. Therefore the information given in previous Year Books will still fill the need of those who are just beginning.

Since high record time models usually require large flying space, it would be advisable to set up a new indoor program which can be enjoyed by all model builders. Bob Copland reports: "We have been doing a new type of indoor flying lately in our rooms and clubrooms. We fly light weight outdoor models around a pole. Mr. Bullock of the Blackheath Model Flying Club is responsible for this development. The model generally about 1 oz., is attached to the pole by a cotton thread. The thread is attached to the wing tip on the leading edge. The best flights to date are about $2\frac{1}{2}$ minutes done in a room about 18 x 15 ft. with a model weighing 1 oz. and about 90 sq. in. wing area.

Chicago Aeronauts are developing the experimental designs such as the helicopter, autogire, and ornithopter. Ornithopter lends itself to any size room and it would be interesting to find out just what it will look like after we have been working on it for a few years. According to reports, the "flapper" is the most economical aerodynamical design. Theoretically, the duration should exceed the prop driven designs on the same power. After all, it is nothing else but a glider with wing tips acting like "scuttle". No torque troubles, no fine propellers to carve, and its low power requirements should hang up high records. The design which holds most promise is that of A. Lippisch.

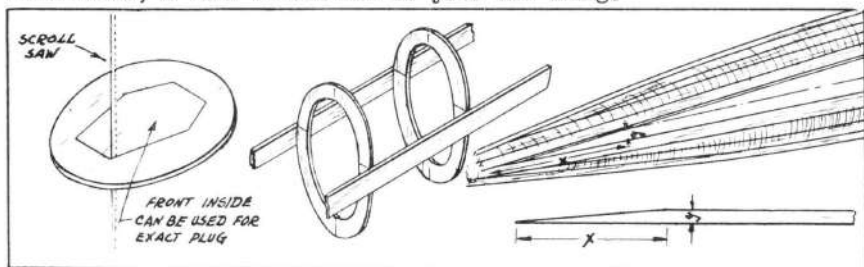


irregular shape, you will have to plot out individual bulkheads. Second Step: Draw full size plan and side views which provide the major and minor axis. Use the approximate method for developing elliptical bulkheads. For ever changing cross-sections, draw two outlines of the largest bulkhead over which are superimposed the smallest end bulkheads. Count the number of intervening bulkheads and space them between the two extremes.



The elliptical and varying cross section bulkhead outlines are drawn on stiff paper. To transfer the outlines to balsa, trim and smooth the paper to the first or largest bulkhead. Circumscribe the outline on balsa, and an extra one on paper to keep the outline for future use or if the bulkhead breaks. Cut away to the next outline & carry on. In transferring the outlines to balsa, be sure to have vertical and horizontal reference lines on balsa over which to superimpose pattern. The circular bulkheads can be outlined directly from drawings by compass.

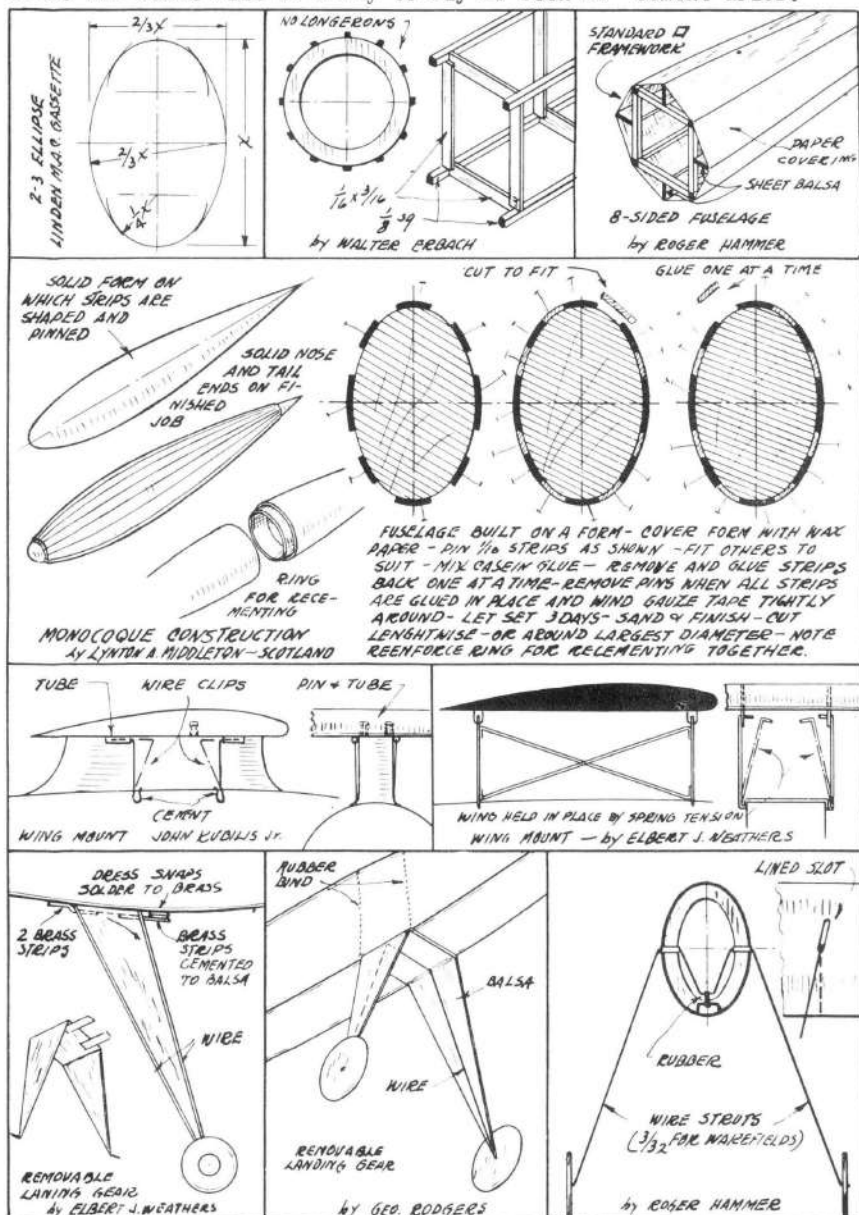
The bulkheads can be single balsa sheet providing that balsa is fairly heavy and of "C" or quarter grained to provide the stiffness. Rigidity counts mostly during assembly. Once the job is completed the cemented junction between the bulkhead and planking provides the "T" section. No stringers are needed if model is planked with 1/16 or thicker planks. 1/20 or under covering require stringers for cementing surface. It might be mentioned that it takes twice as long, with poorer results to cover with thin sheets than it is to use planking. Since single sheet bulkheads are liable to crack if cut with razor, a fine scroll saw is just the thing.



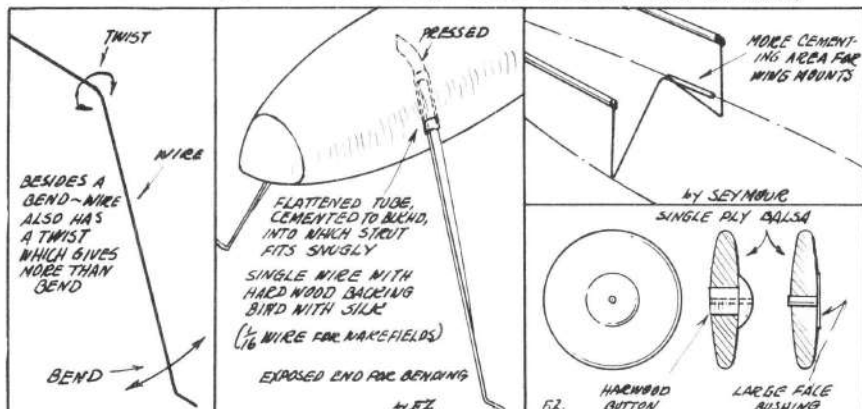
The assembling is begun by using two 1/16 x 1/2 master planks on which the bulkheads spacing are marked. (2" spacing seems about the maximum allowable.) Tack to the strips with cement the two bulkheads which are on either side of the largest. Be careful in doing this as it forms the base for the entire structure. Check up for line-up of two strips by bringing the ends together, and pinning them temporarily while the rest of the bulkheads are cemented into place. With all bulkheads in place start planking. (Planks should be of lgth and soft balsa.) Begin by cementing top and bottom, to prevent twisting or curving. To cover angles, just measure the length of the angle to the point where the width equals plank width, and cut a straight angle. The softness of the wood will allow jamming and so fill cracks.

While planking be sure to mark all cut-outs deeply, such as the wing mountings, and also cement-in all wire fittings to the bulkheads with plenty of cement. When planking is complete, sand with medium

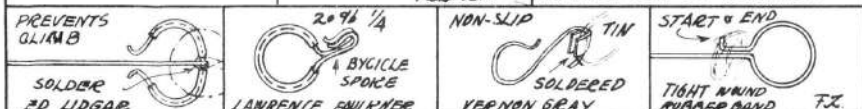
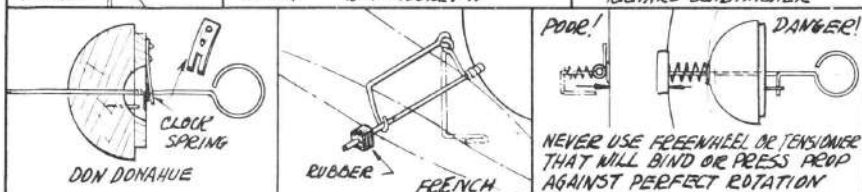
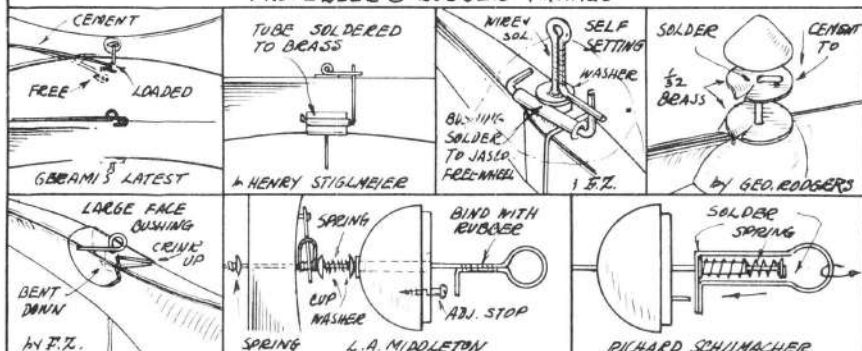
paper as long as the planks resist bending or have no light spots. Final fine sanding after a light coat of dope. Cover with paper, light color preferred as dark color will show up junction streaks and also cover up the natural wood grain, coat with 6 application of banana oil with final fine sanding and waxing. The banana oil is best as it dries up rock hard with lightness. --- You now have a light fuselage which will take 40 strands of 1/8 with ease even if they smash back. After a while you will find parts of bulkheads missing without weakness showing up. Or after a series of head on smashes the front might weaken and crack off, but you just fit it back and smear it with cement. The model will be ready to fly as soon as cement dries.



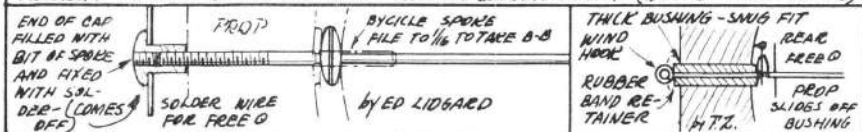
LANDING GEAR: The beauty of wire landing gear is that it never breaks. But it sometimes proves a disappointment in way of ground stability. Single wire strut seems ideal but the gauge will have to be large to sustain the weight of the model. Abamboo or hardwood stiffener helps, out there is still another weakness; the ease with which the wire may be twisted. Sketch shows how bends weaken the landing gear struts. The ideal strut would be as shown which just enough free wire to provide the needed "spring". Be sure to use silk to bind wire to wood.



PROPELLER & RUBBER FIXINGS



PROBLEM: REMOVAL OF PROPS WITH ALL MODERN GADGETS ON WAY- (WEBER SOLVED IT-P73)

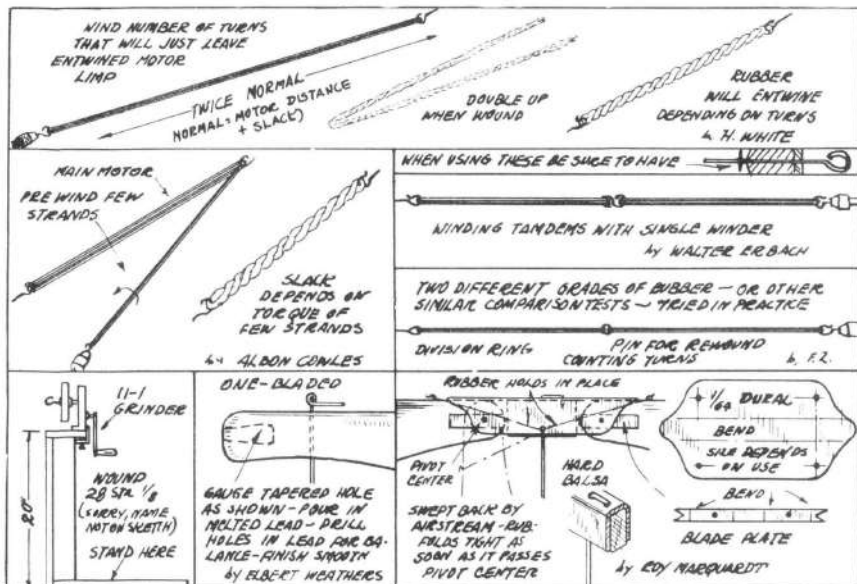


INHERENT RUBBER TENSIONERS: The original was developed by H. White of the Northern Heights M.F.C., London. The idea is sketched below. The initial turns are critical as they decide the tightness of the entwined motor. Used extensively in England. ---Bob Copland

FROM AMERICA: Use few strands with an apposing prewind. This prewind will turn the motor backwards until both torques are equal. While unwinding, the entire motor will only turn to this balance of prewound strands and main portion. -----Albon Cowles.

PUSH-PULL WINDING: To obtain equal number of turns and wind at the same moment with ordinary winder, wind in tandem. --Walter Erbach.

TESTING DIFFERENT GRADES OF RUBBER: Wind the two grades in tandem. Weaker will break first. Winding and then unwinding ONLY ONE, shows which has most torque. The more powerfull will naturally have less turns. This test may be applied to many variations. ----by Editor



RUBBER

Turns per inch on Two Strands--Weight per inch of Single Strand

Size	1/32	3/64	1/16	5/64	3/32	7/64	1/8	5/32	3/16	1/4
Turn	225	189	163	145	130	124	115	108	94	80
Wt. oz.	.0005644	.0008466	.0011288	.001411	.0016932	.0019756	.0021576	.0028220	.0033864	.0043152

Turns per Inch on Multiple Strands (For 1/30 Brown Rubber)

No.Str.	4	6	8	10	12	14	16	18	20
1/8	80	64	55	50	44	40	36	34	32
5/32	68	59	50	46	41	38	34	29	24
3/16	60	54	46	42	38	35	32	27	24
1/4	56	44	37	33	29	27	25	23	21

GASOLINE MODELS

The most pressing problem in gasoline model field is the spiral stability. It is hoped that before you attempt your next design you will have a good mental pictures of what goes on by getting thoroughly up with the theory herein presented. If your present models are giving you trouble, check on the points specified and do not be afraid to make changes. It is the one and only sure way of tracking down the trouble.

The new weight rule changes the picture considerably. Heretofore we stressed the wing loading, low as prudence allowed. But with the wing loading fixed to a minimum of 10 oz. per sq.ft. our next bag of tricks is low power loading, or is it high power loading. A lot of power for the weight is what we want. For example: Say we need 1/5 H.P. to fly a seven pound model with a wing loading of 10 oz. per sq. ft. It is evident that if we decrease the weight to 3½ lbs. and still have the same wing loading, the power could be almost cut to 1/10 H.P. The H.P. required formula being: $H.P. = \frac{\text{Drag} \times \text{Velocity or Speed}}{375}$

Wing loading remaining the same, the velocity stays as on the heavier model. But because of smaller size the Drag will become much smaller and the extra power can be used for the climb. Because any power excess of that required for horizontal flight can be turned into a climb. So, the new rule defeats its purpose of keeping the model in the field but it does compe the builder to build stronger models which is a step in right direction. Duration should not suffer because of increase of wing loading since most of the duration comes from the glide. If we are careful in our selection of airfoils and especially the trimming we can almost make up for the increased wing loading.

Since it is our aim to get the maximum performance out of a model we are compelled to assume the high power means of trying to keep ahead of the field. The ideal job would be a streamlined power plant with imaginary wing and tail. The closer you achieve this point in practice, so much better are your chances. But this high power will bring up new problems which usually crop up with increase of speed. So that the discussions on rubber models should be timely for gas models. Also, it will be doubly more important to know your aerodynamics. The models will also have to be made stronger to stand up against the gaff. We have seen many jobs fold up in air because of too light construction. The plans shown in the book have fair spar sizes but you must be careful to use hard balsa. The construction of monocoque fuselages is similar to that described under Rubber Models. The only difference being is that planking should be thicker, the bulkheads need not be cut out, model covered with silk and doped with colored dope. Ordinary "boxes" are also showing up with balsa sheet & silk covering combination.

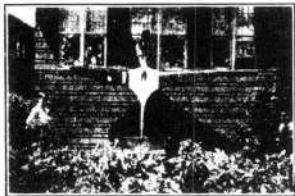
Cocensus of opinion on wing construction is for standard framework with silk covering. Also that color doping should be thin to allow light to show through the covering for better visibility. Airfoil Göttingen 497 seems to be the favorite now. Inspection of the plans and their performance should give you a good idea what is best. In fact, the reason for including so many plans is to present a fair cross section of the art so that you may profit by others' experience. The prop brekage is going on day in and day out. The folding prop presented here has had a great many succesful flights with landings that wiped off the landing gear. It was also noted that too strong props either wood or metal tend to crack crankcases with sad regularity.

Engine recommendations: Plans list the make of engine used. We are sorry that we cannot tear every engine apart and give you the low down. Some engines are excellent while others need immense patience & and kindness of heart. A good stunt would be to have the club pool to buy a particular engine, give it the works, and order in the future according to the performance.

CANADIAN AVIATION

The Single-Bladed Propeller
By DON G. McLEOD

EVER since the single-bladed prop was given publicity in the United States some time ago on a Taylor Cub, a great deal of interest has been aroused among aviation fans in all walks and



Equipped with a single-bladed propeller, Don McLeod's CW-3 soared out of sight after 30 minutes. The ship and its builder are shown above.

particularly in model building circles. Two thoughts have sprung up, those for and those against. To those die-hards who are afraid of their crankshafts, the author begs their undivided attention later in the article. He also wishes to state that there is quite a field open in this direction and the words, statements, etc., hereunder are subject to some debate. This is written with the hope that other experimenters may profit by his experience.

The first experiment that I can remember took place about ten years ago. An old standby, an R. O. G., cracked up, shearing off one of the detachable prop blades; a safety pin and a paper clip restored balance and the R. O. G. flew very well until its ultimate destruction took place as is wont to happen. Observation showed a faster climb and flight. Several subsequent models, when accidentally flown with broken prop blades (what model builder has not done this?) showed a beautiful series of "galloping oscillations," rendering the flight of the model unfit to be talked about except after contests. In spite of the wiggles, they did manage to speed along a bit.

Nothing further was done along this line then, due to pressure of schoolwork brought about by thoughtful parents.

In 1933 it was my intention to use a single-bladed prop on my Wakefield model, but unfortunately for some reason or other the idea was discarded. Consequently it was not until 1935 that it was again tried, this time on a semi-scale Dewoitine of some 44 in. span. Briefly some improvement was noted but the model was washed out on a house top and lack of time prevented following up.

Then came gas models. In the spring of '37 the first single-bladed prop was tried on my Brown Jr. Several experiments followed until the final design as tried on CW-3 resulted in a new open class record. Let me state here that I do not believe the flight was due entirely to the prop in this case but it was partly responsible.

The first prop used was, for simplicity made with a fixed pitch. This gives much better results at the take-off than the two-bladed prop as the single travels in undisturbed air and takes a perfect bite; consequently the climb after the take-off is also better. The actual results of the L/D ratio of the prop will more nearly reach the theoretical; thus a much higher L/D section may be used. A slightly higher pitch may be used and the diameter may be increased; the latter should not be more than eight to ten per cent of the original diameter. Both P and D should, of course, depend on the type of aircraft; I have found here that practice is ahead of theory. The angle of pitch of the blade should not be excessive, however, as the blade will stall.

The area of the prop should be at least 80 per cent of that of the standard prop. It should have a taper ratio of at least two to one, i.e., the blade should be twice as wide at the centre of the radius as at the tips; in fact it can quite profitably be 2.5 or 3 to one. One must remember that the tip speed is twice as great as half way out; also remember that double the speed gives four times the lift. A good clean blade shape with as narrow a hub as possible is essential to cut down any blanket areas.

The blade profile is also very important. Too many fellows are inclined to let any old thing do. It may do for fooling about with but no real value will ever be

learned. Pick out a good foil and stick to this as closely as possible. Absolute accuracy is impossible for us as the section is too small.

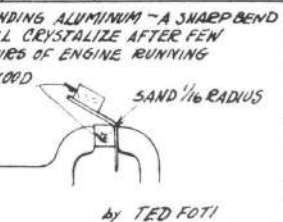
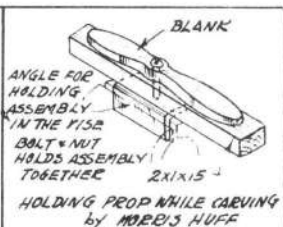
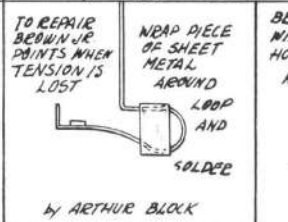
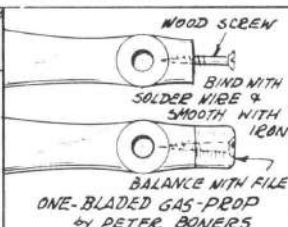
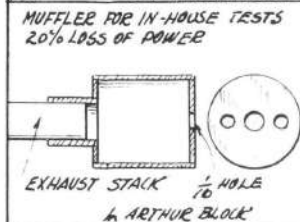
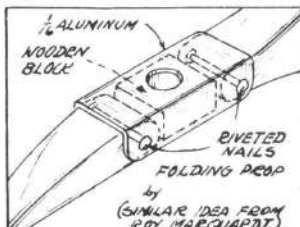
Here also, is where the single has it over the standard prop. Due to the small profile shape it is practically impossible to get both blades identical. With the single this is not necessary and so a statically and dynamically balanced prop is more easily obtained. Nevertheless profile shape is important. One must remember that slight changes affect the performance quite readily. This may be easily understood when one realizes that the tip speed with the Brown, for instance, runs from 250 m.p.h. at 6,000 r.p.m. to 400 m.p.h. at 10,000 r.p.m.

The weighted end of the prop (the ballast here consists of lead) should not be greater than 20 per cent of the prop radius. The closer the better but naturally the weight will be excessive if care is not used. The weight should be securely fastened on by a cleat of sheet metal as the centrifugal force is quite high and increases to the square of the r.p.m.

The design of the blade should be such as to allow the C.G., if possible, to be right on the centre line. This makes it easier to balance as well as giving a smoother running prop. To those die-hards, please note: the centrifugal force of the blade is balanced by the centrifugal force of the lead, only, however, if the prop is in static balance to begin with. The crankshaft is in no danger of being twisted off as many gassies and aircraft men were wont to think.

In closing, tests showed that the flow of air behind the single was much smoother than that of the two-bladed prop, especially as the speed increased. (This was accomplished by cementing threads to a rod at intervals of an inch and then placed in the slipstream. The higher the speed the more noticeable was the difference.)

Unfortunately the thrust balance necessary for making a direct comparison is not completed as yet. However, very shortly data on the single fixed pitch, a constant speed single, a standard prop, and a controllable pitch two-bladed prop will be available. Space permitting this will be published in a future issue of CANADIAN AVIATION.

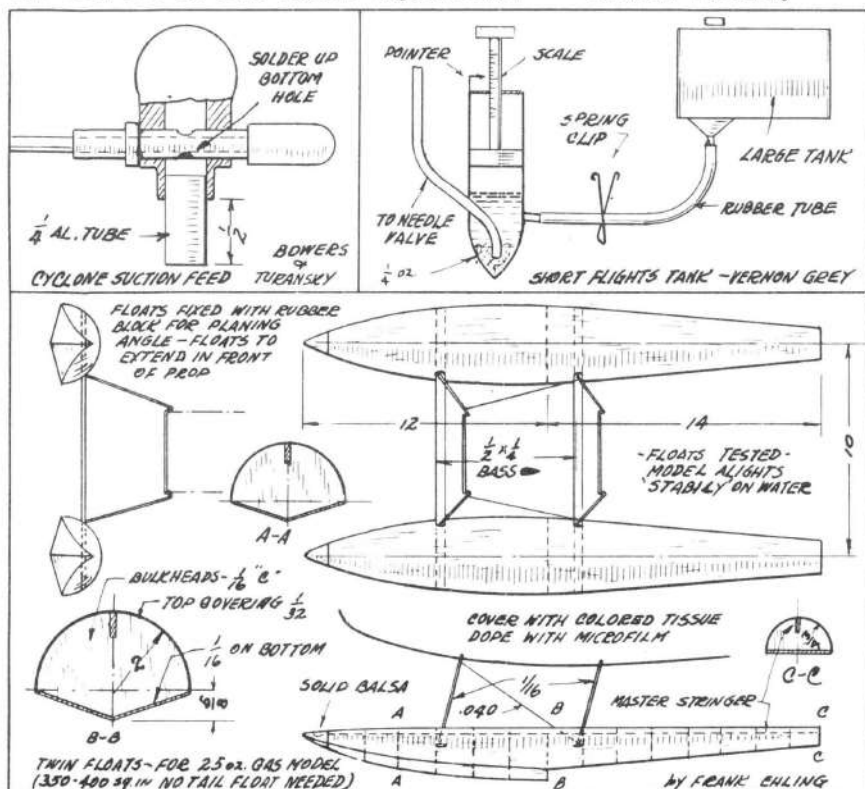


LAMINATED BULKHEADS: CASCO Casein glue is best for 3-ply gas model bulkheads. Of course the 2 in. wide sheets are cemented with cellulose cement edge to edge. The the plys are joined with CASCO. It is excellent for large surface balsa joints such as leading edge spllices on gas models. CASCO does not soak away, and while it is setting it is partly independent on the exposure to the air. It does not take more than overnight to harden.-----Herbert J. Drake Easton, Pa.

FOR TYING PARTS with rubber on gas jobs, use strips of ner tube out spirally under water with scissors. This rubber is less affected by light and air. It stretches enough for most uses.--Curtis Janke

BABY CYCLONE SUCTION FEED: "I use suction feed on Cyclone to keep it from revving down in a steep climb when it is inverted, or when the intake is too close to the level of the tank. The idea is sketched. That is all there is to it, just stopping up one of the holes in the needle valve seat. The tube idea is not original with me. I saw it first used by Howard Roberts of Palo Alto on an inverted Cyclone. The motor is started on gravity feed, but once running, it will feed by suction from the tank, even though it is far below the intake. Since the Cyclone is so economical on fuel, it has not enough suction to be able to start well on it, although some of the boys manage to do it."-----Peter Bowers

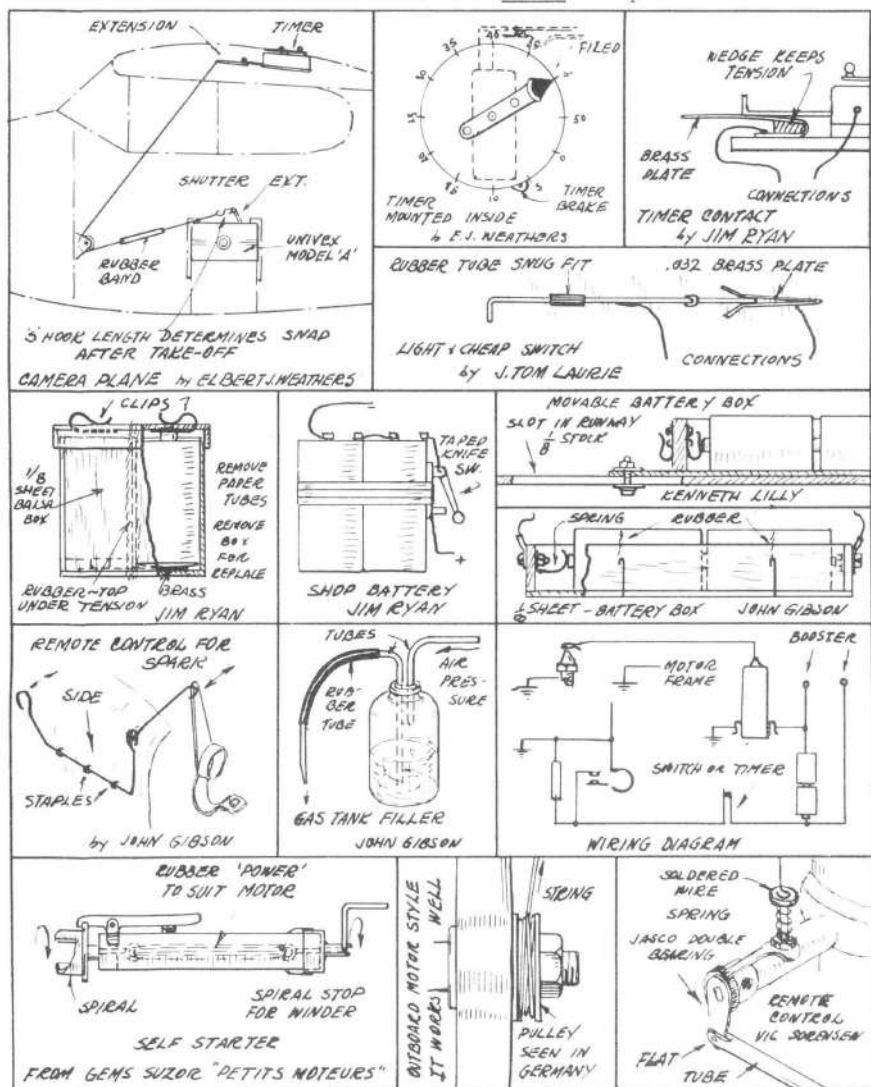
ANOTHER MAN with same idea. "I have had it on my motor for 5 months and if you shut your eyes and start the motor you would think it was a Brown.--From now on always mount the gas tank below the level of the intake and you can forget about turning the needle off. The motor will run on same needle adjustments."----Clement Turansky



GAS MODEL ADJUSTMENTS: "For slow and medium ships I use just enough right thrust to counteract the engine torque, so that the turn is controlled by the rudder, and the circle in the glide and under power is always the same size.--- On high power thirty seconds motor run jobs I use the good old hand launch glider adjustments; right turn under power and left circle for the glide. It sure grabs altitude! On these fast jobs, too I mount the batteries and coil high. This makes the turns flatter."---Peter Bowers,

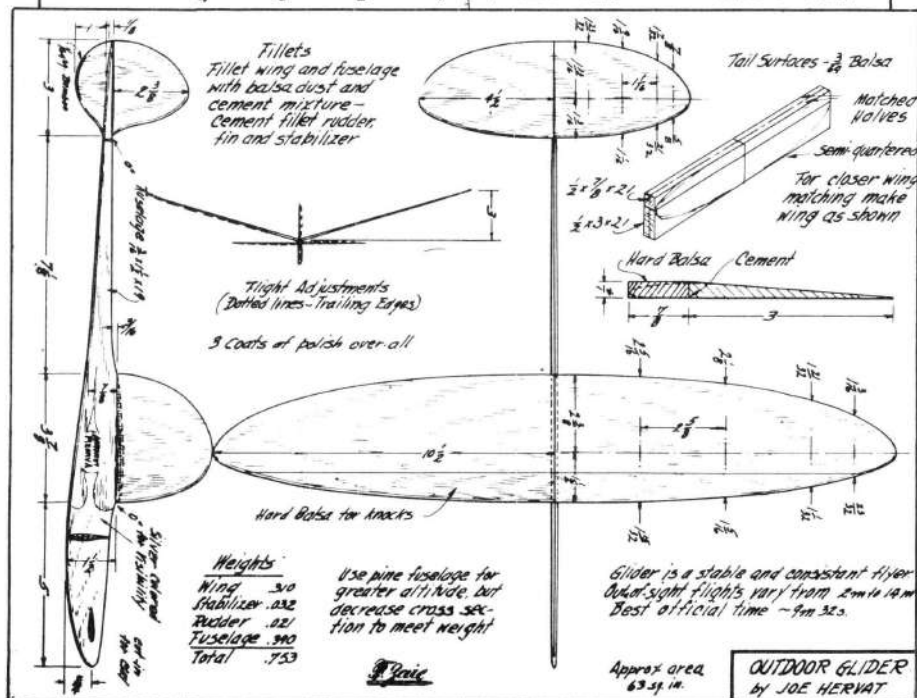
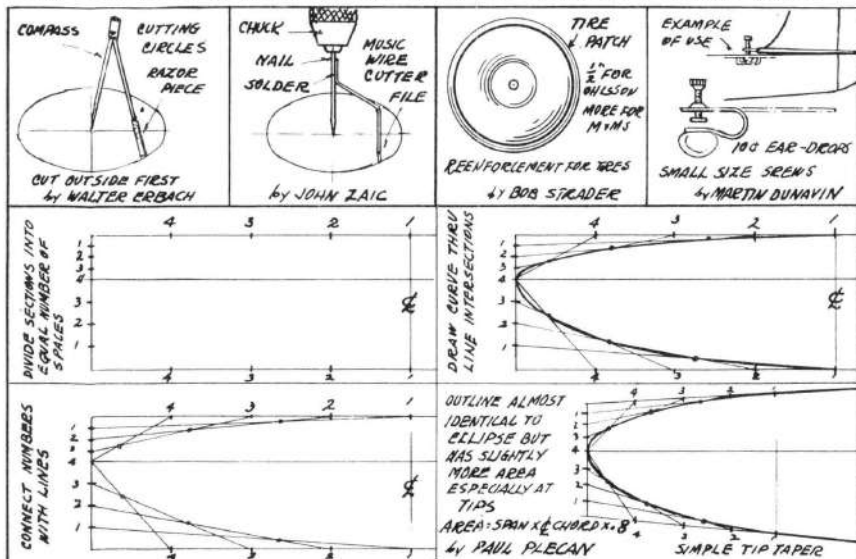
IDENTIFICATION SLIPS: "Instead of typing the identification slip on white card, do it on the covering tissue. This makes a neat and permanent job after it is doped over."---Gilbert Wehrenberg.

ELECTRICAL REMINDER: For best results use fresh batteries, solder all connections and do not mount coil with metal straps.--N.Smith MFG.Co.



COVER FUSELAGES with light-reflecting colors. They absorb less of sun's heat and keep rubber cooler. Silver seems best. Can be seen. INSTEAD OF SOAKING in acetone, clean dope brushes before dope dries by rubbing with moist soap until lather. Then wash out with water. TO REMOVE CRUSHED spots on indoor motor sticks and such, moisten the spot with water. Let spot dry well before using.---Walter Erbach

STAIN YOUR WORKboard a dark color so that you can see what you are doing when sanding small strips of balsa to size.---Curtis Janke



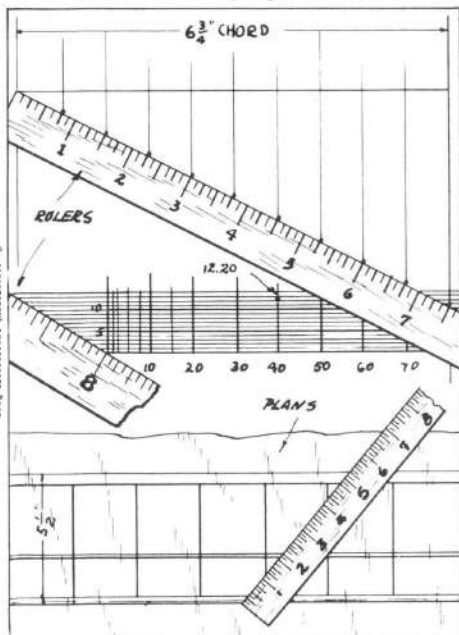
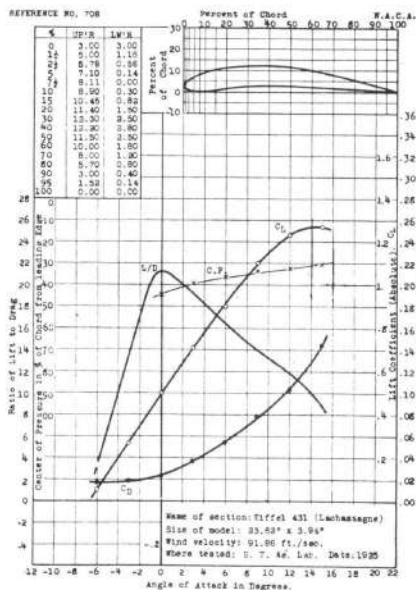
PLCTTING AIRFOILS

Plotting airfoils from ordinates is simple once you tackle the job and go through with it. The hardest part is to divide odd size chord into ten equal parts. This is easily done by using a geometrical trick. For example: Divide $6\frac{3}{4}$ " chord into ten spaces. Draw two vertical lines $6\frac{3}{4}$ " apart, connected by airfoil base line. Place 'O' of a ruler at the point shown. Move the other end down along the line until $7\frac{1}{2}$ " is superimposed on the line. Pin point along the ruler edge every $\frac{3}{4}$ ". ($10 \times \frac{3}{4}$ " = $7\frac{1}{2}$ ") Draw vertical lines thru these points. Result: $6\frac{3}{4}$ " divided into ten equal spaces. For other sizes of chord, select a length on the ruler which can be easily divided into ten and be just a trifle larger than the chord. Ex: For $4\frac{1}{4}$ " chord use 5".

Having 1/10 chord spaces, it is simple to subdivide them into smaller portions as required by the ordinate table. For horizontal lines bring up one or two 1/10 spaces. Subdivide them into 10th parts as above. Be sure to be exact as spacings are small. With graph completed the fun begins. If you carefully number the lines you should have no trouble in locating a particular point specified by ordinate. Ex: The point for upper camber on 40% chord vertical line is 12.20. Count out twelve 1/100 spaces, and with eye subdivide the 13th and pin point the estimated .20 spot.

The airfoil shape is completed by connecting the pin points with a French Curve. Cement the drawing on stiff Bristol Board, fibre or metal. Cut roughly to outline and finish with sand paper. If template is soft, outline it with fine wire (.014), for razor contact.

It is surprising what one can do with this diagonally held ruler. It is easy to find out most detail dimensions if main dimension is known and drawing is in proportion, not necessary to scale. Just superimpose the ruler diagonally until main dimension is read on scale. For small plans you will need Architect scale which has many sides with different scales, from 3" to Ft., to $\frac{3}{32}$ " to Ft. With such a variety you can scale off most of the three view plans shown in magazines. (Note: Drawings of plans in this book are in proportion.)



RUBBER TURNS & TORQUE and PITCH

by J.P.Glass

Basic formula for finding number of turns that can be stored in a rubber motor is:

$$\text{TURNS} = \frac{K \times \text{Length}}{\text{Area of Rubber Cross Section}}$$

The following calculations are based on 1 strand of 1/8 x 1/30 Brown Rubber as a unit of Area (A), and on 'K' whose value was found to be 163 when using Brown Rubber. Our turn formula (good only for Brown Rubber, T56,) is as follows:

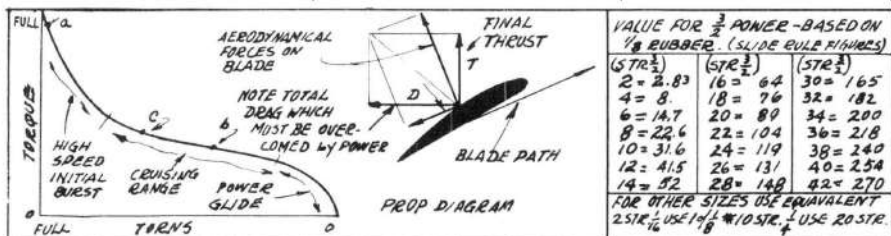
$$\text{TURNS} = \frac{163 \times \text{Length of motor of new rubber inches}}{\text{Number of 1/8 strands}}$$

EX: 10 Strands, 1/8 width, 30" long.

$$\text{Turns} = \frac{163 \times 30}{10} = \frac{4890}{3.16} = 1540 \text{ Turns}$$

It was found by experience that as the strands multiply or have a thick motor, you will fall a little short of the above formula value. Therefore, for 10 strands you can safely expect 1500 turns. With thicker motors you will have to subtract even more. With motors using less than 6 strands the formula will produce the correct number of turns. The length of the motor has no bearing on the number of turns. Turns calculated from this formula are on safe side. (Turn tables shown elsewhere in the book were originally calculated by this formula. Editor made actual tests to check the values, and test turns were so close that the above formula can be accepted as a sure thing, Ed.)

Do not forget that the formula is based on cross section of rubber in terms of number of 1/8 strands. For example: 2 strands of 1/16 will equal 1 strand of 1/8. Or: 18 strands of 1/4 will equal 36 of 1/8.



TORQUE

Basic Torque Formula — Torque = $K (\sqrt{A})^3$ or $(K A^{\frac{3}{2}})$

For convenience it is better to express torque as a matter of work done in one revolution, which is really $2\pi \times$ Torque. If we use inches in the 2π product the results will be in inch/ounce. This 2π factor is already taken care of in the 'K' value. Formula for torque on rubber motor is:

$$\text{Work per Revolution} = K \times (\text{Number of Strands of 1/8})^{\frac{3}{2}}$$

'K' or the coefficient varies with torque curve. For example: When you start to unwind a rubber motor the torque at 'a' is several times greater than at center 'b'. The average torque is at point 'c'. But for practical purposes it is much better to use the torque at 'b' or half unwound point because the propeller is very inefficient at high torque and throws away the initial burst of power. Since we are most interested in the portion which last longest and on which we hope to continue having a good cruise or moderate climb, we should use the point 'b' as the determining factor in finding the value of 'K'. Experience and practice showed .4 as a good value for 'K' when T56 Brown Rubber is used. Our torque formula then is:

$$\text{Work per revolution} = .4 \times (\text{Number of strands of 1/8})^{\frac{3}{2}} \text{ in./oz.}$$

Ex: Using our 10 strands of 1/8 motor (Length has no bearing) we get:

$$\text{Work per revolution} = .4 \times (10)^{\frac{3}{2}} = .4 \times (31.6) = 12.65 \text{ in./oz. per rev.}$$

(The power $\frac{3}{2}$ means to extract square root of the number and raise to)
third power Ex: $(10)^{\frac{3}{2}} = (\sqrt{10})^3 = (3.16)^3 = 31.6$

This means that one turn of the 10 strand motor will lift one oz. 12.65 inches if pulley is 100% efficient. At start it would of course lift several times as much. This applies only at the instant when the motor has been tightly wound and half unwound. It represents a good average value on which the model should cruise.---This also means that if the plane has a drag of 1 oz. and if the prop is 100% efficient, the rubber has enough power to pull the model 12.65 inches in one prop revolution. Or if the drag is $\frac{1}{3}$ oz. the pull will 38" in one rev. But experience has shown that props are inefficient:

55% to 40% for Indoor. 60% to 50% Outdoor. (Depending on care and finish)
This means that our 12.65 inch pull is reduced to 7 inches, and the 38" to 20" if the prop efficiency is 55%. --We now have numerical values for torque, developed and delivered. (Del.Tor. = Work per rev. x prop eff.

PITCH

Geometrical Pitch is found by knowing torque, drag of the model, actual pitch and slip percentage. We have already calculated for torque The drag is found by gliding the model, in still air, without prop whose weight is substituted. EX: If model glides 100 feet from launch height of 16 feet, the L/D is about 6. If the plane weighs 2 oz. the drag is $\frac{1}{3}$ oz. For 8 oz. model the drag is $1\frac{1}{3}$ oz. Actual Pitch is found by:

Actual Pitch = $\frac{\text{Work per rev.} \times \text{prop efficiency}}{\text{Drag of the model}}$ Ans. -inches

EX: 10 Str. $\frac{12.65 \text{ in/oz.} \times .55}{.33 \text{ oz.}} = 20.9" \text{ A.P.}$ $\frac{12.65 \text{ in/oz.} \times .55}{1.33 \text{ oz.}} = 5.2" \text{ A.P.}$
1/8 motor

Before giving values for Slip Percentage we must make clear the difference between it and the prop efficiency. Slip is the difference between actual and geometrical pitch, and it determines the angle of attack of the blades. While prop efficiency depends almost entirely on the L/D of the blade section under actual operating conditions. That is, high angles of attack, rough surfaces, poor airfoil section will produce low efficiency value because so much power is wasted in overcoming the prop defects. While low angles of attack, highly polished blades and good airfoils will produce high efficiency props. By knowing these requirements you can estimate the efficiency values. EX: If we assume that of the 100% available power or Work per Rev. we use 45% to overcome the drag and other factors of the prop, we will only have 55% of it to convert into forward action or thrust through the prop.

Under most conditions, of proper blade area, rubber length, P/D ratio and etc., 25% added to the above Actual Pitch is a good guess for Geometrical Pitch. Therefore, our 20.9" A.P. becomes a 26" Geo.P. and 5.2" A.P. will be 6.5" Geo.P. The exact Slip Percentage will depend mostly on blade area. Comparatively large blade area will have less slip so that 26" Geo.P. can be cut down to 23". But if the area is small, you cannot add more Geo.P. because the blades will stall & so increase drag. It is better to be on the safe side with enough area, especially since large blades would be more efficient at start.

We can now calculate for Geo.P. on which we can base the size of our prop block. Pitch/Diameter Ratio determines the Diameter. P/D for models using rubber motor is 2. Take our word for it. Ex: $26"/X = 2$ X = 13" diameter. Next job is to determine width and thickness. ----- Sorry but we have no simple formula available to take care of this. But we can keep this in mind. A low pitch travels at high speed and needs less area. A high pitch travels slow and needs larger blade Area. Perhaps we could evolve a formula based on wing area and loading which would furnish us with speed, weight and drag of the model. But until more tests are made, we will resist the temptation of working out theoretical values. However, it might be mentioned that correct Geo. P. is more important than the blade area, especially under present trend of using considerable blade area. So use the calculated Pitch and estimate the blade area according design's cleanliness.

SPECIAL NOTES ON MODELS SHOWN AS GLEANED FROM CORRESPONDENCE

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Peter Bower

Amphibian Gas Model

The biggest problem was the design of the hull. I took it up with the prof. of the Guggenheim Aeronautical Lab down at Stanford, but he was not much help. All he said was that once it got up on the step, it would be able to get off the water, if I kept to the wing area and power loading I had designed for. His only suggestion was the addition of step vents, to cut down the water suction and enable the ship to get on the step itself. Ofcourse, a push will get it up, but what is the fun of that? Another reason why I am sure it will be able to take off the water is that the wing and tail have a positive angle of attack, relative to the forward motion of the ship on the water. This means that before the plane is moving fast enough to get lift from the top surface of the wing, it is sort of kiting on the lower surface and so helping to ease the ship off water.

The model was first tried as a seaplane, and it did not get off the water, although it got up on the step quite nicely. Next I tried it as a landplane, and it still did not get off the ground. Adding a couple of degrees of up-thrust cured the high-thrust-line trouble, and she got off alright for three sweet flights. She is quite fast, and not as steady as big light jobs go, but she is stable, and that is what counts. Due to the very high line of thrust, she flies with tail high and starts a loop when the motor cuts. She pulls out of that, and comes in on a flat circling glide.

The upthrust cured her water troubles too, and she takes off like a real boat, planing along for nearly a hundred yards before breaking off and climbing. I got only one water-hop out of her as something slipped in the air. The only damage was a smashed pilots cabin when the model hit the water. I shudder to think what would have happened if she had hit on land. I forgot to mention that on one of the previous tries, when she was planning at full speed, one of the wingfloats snagged a floating bush and flipped the ship over on it's back. I pulled it out, took the cylinder off the engine, dumped out the water, put it back together and tried it again. The bus was bujit to take just such beatings.

The ship does and is strong enough for a Cyclone. I had it in mind when I designed it as I had my doubts about the Brat being able to get it off the water. However, the Brat has plenty of power and takes that plane to places in a hurry. It is quite faster than any of my other ships, even though it is big for a Brat. It does not need much headwind to get off, just enough to ruffle the water is all that is necessary.

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Lawrence Faulkner

Geared Model

"The gear arrangement is very good for flying scale models. These models are usually smaller, requiring shorter motors which would be easy to handle. The gears put weight in the nose and make possible a short fuselage and small propeller, all of which are very desirable in flying scale models. The model and the gears were finished in NOV. 1937. It has had approximately 90 flights. I live close to a lake and most of the flights were made using the ice of the lake as a flying field. I make about 5 flights before the motor becomes so cold that the model will not climb. Winder wound, the average duration is 70s. I expect better flights in warmer weather."

"During first flights I used right hand prop but later changed to a left hand so that the motor could be wound right. I spent about a week experimenting to build the gears. The chief trouble was in finding bushings to fill the space between a 1/16 shaft and the shaft hole already in clock gears. Also I had such a large collection of wheels and clocks that I did not know what I wanted to use. I have tried rear gear arrangements, but I had trouble in getting the lower motor to unwind. After considerable experimenting with gears I have decided that a fairly long fudage with rubber tensioner combination is better for purely duration models. I might mention that I had bent shafts with my front gear assembly but this did not bind the running of the gears, very likely because of thin lower gear which can swing on upper teeth without binding."

"The biggest bug in using a gear device is the general weakness of the assembly coupled with a terrific loss of power in friction. Now on my motor I went through a lot of trouble reducing friction in it, and except for a weakness which I have now rectified, the gear device was as strong as necessary. To my way of thinking using a large supply of rubber is the best way to bring up the weight. I definitely approve use of gears.

My model flew perfectly on its very first test and according to Rushy when he flew it, it was the most stable of ships. Lovely climb and good duration. The first flight was well over three minutes and the model most certainly would have placed high had not one of the gear shafts given away. You see, instead of bending the hooks in the ends of the shafts to take the "S" hooks I foolishly went & drilled small holes in them. This so weakened the shafts that they would not take strain imposed by so much rubber.

The motor was made up from brass gears procured from Boston Gear Works, and the box containing the gears was machined from a piece of celeron, a very tough sort of fibre composition. Ball bearings eliminated a lot of friction. I certainly expect to hang on to the gear idea."

"I have nothing new on the paper mache but I might say that such models work out swell with the new weight rule because a large model may now be given an extra coat of paper and a couple of coats of dope thereby making the model much stronger than before. All class "C" and "D" models should have four layers of paper except in an unusual case such as the one I drew plans for where I used a wing mount to bring the fuselage up to the correct cross section. All paper mache fuselages should be given one or two coats of clear dope with a light sanding after each coat. They may then be given a coat of colored dope."

"This pusher will fly without much trouble, just push the wing and elevator forward and backward until suitable adjustment is found. The plane made 4m on its first flight before it entered a cloud about 1500 feet overhead. It was seen coming in and out of the cloud several times before it was completely lost. Since then three more pushers have been built, identical with exception of using one bladed props on the last one. The model with half blades also flew 4m on only half possible winds. This design of the prop helps to reduce drag in the glide which brings the design in par with single prop models. It is my belief that with the rise of the weight rule, the twin pusher will come into its own since they have normally been always over weight. With tractors and pushers on almost equal weight rule conditions, all we need is proper streamlining on pushers to make the tractors watch out for its standing."

"To convert the ship to 3 oz. per 100 sq.in., use 16 strands, 30½" motors. The fuselage will easily take this extra rubber as I am now using 18 strands. The only other change is in the props, use 30" Pitch with no greater than 16" diameter. A greater diameter effects the spiral stability too much. The props could be cut from 1½" x 1½" x 16 blanks. The new props should not weigh more than 5 and 4 gr. for front and rear respectively. You may think my props extremely light for outdoor ship but I found that light flexible props survive crashes better than rigid. Also, there are very few crashes with this type of ship as a stall results in no spiral dive or crash. The only real danger is that the model may not stall but continue on up and over. And then, what speed! Warning: Make sure the surfaces are held with tightly stretched bands so that they will take high external load without "giving" but will break if there is an excess load due to a mishap.

HISTORY: To start with, the P-P idea seemed to me the practical method by which a larger amount of rubber could be used and at the same time to do away with large torque reaction which is ordinarily evident on fuselage models. It

seemed better than to use gears or co-axial props for a number of reasons. With a gear drive quite a bit of weight is added and they are rather hard to get operating efficiently in actual service. Also there would still be the torque of a single prop even though it was running at a high speed and comparatively low torque. Co-axial props bring up the mechanical difficulties and efficiency of props working one behind the other.

These considerations led me to experimenting with small stick jobs. I found that I could almost double the length of power flight but the glide was poor. However with the advent of freewheeling props and with the application of a good type of freewheeler particularly to the rear prop - I am able to get a glide and sinking rate comparable with the best tractor models.

The first fuselage design had consistent flights but maximum duration was only 1m 30s. It would cruise at low altitudes and then just settle to earth. It showed no soaring tendencies. I changed the wing design, high lift, low drag & thin airfoil section. The model then tried to loop under power and "gallop" in a glide. If it did not loop, it stalled, slipped back, recover and etc. It behaved better when both thrust lines were adjusted to go through or above the C.G. but then it had a crazy tendency to come down in diving spiral. The real solution came when I used a larger and a lifting elevator and by experimenting set the rudder so that the ship would fly right or left circle according to which way it wanted to fly naturally.

The stability attained when the model was correctly and finely adjusted was as good as that of a tractor. The lateral stability and freedom from dives or stalls was also improved by experimenting. Proof; the original 1933 fuselage is still servicable.

ADJUSTING P-P-: The tail should be set to give enough lift so that the plane has a good glide when the ship balances between the rear third and half of the wing. The prop thrust angles are then adjusted accordingly so that the ship does not stall or turn over when under power. Both thrust lines should be changed at once so that their intersection lies along the vertical C.G. of the ship.

Both, longitudinal and spiral stability can be improved by using a fuselage whose shape does not contribute much lift or which has a negative Center of Pressure travel. Hence the reason for the odd shape of my fuselage. It would have been still better if the general contour was followed but use an elliptical cross section instead of rectangular. The important thing to keep in mind about P-P cabin design is to minimize the effect of the side fuselage area. Use high lift wing, lifting tail, adjust thrust lines very carefully and allow the ship to turn on its natural circle.

" As for flying scale, before the advent of the gas model, it was the most popular model around here. And as the result, I think the State Fair has the best set of rules used. I picked the Brown because it had fairly simple lines and was to my estimation, well proportioned for a model, i.e., enough rudder, stab area, snappy looks and some dihedral, which means that by putting some more dihedral for good stability it would not go as hard with your rating as if the real plane was rigged with none. The results proved very gratifying.

I had one at the '36 Fair that had a M-6 airfoil and a motor stick. The model flew well but the glide was not the best; placed 2nd with it. Last year I built another one and put a rubber tensioner and an undercambered wing section and took away the motor stick. The performance was, as you would suspect, remarkably improved. The airfoil section (suggested by Rod Doyle and drawn up by me) worked like a charm and the model has a good glide as the average fuselage design. The ten strands of 3/16 gives the model a near 'Tulsa Climb'. I hadn't played around with it enough but I think that it would almost give the fuselage a competition if it was properly tuned up.

Incidentally, the fact that it is a low wing doesn't seem to hurt the performance a bit. As you notice, it has no down thrust which helps a bit to prove that the right thrust adjustment is better than putting more negative in the stabilizer of a low wing. It allows the model to be adjusted for the best glide

and power flight, and not the best power flight alone. Also note that if you choose the right plane, it is not necessary to enlarge the tail surfaces and so make people ask if you designed it all by yourself."

'37 CALIF. STATE FAIR FLYING SCALE MODEL EVENT

SPECIFICATIONS: A flying scale model shall be as nearly as possible a replica of a U.S. Military or Commercial man carrying airplane manufactured in the U.S. since Jan. 1st, 1936 and shall represent to scale all the essential parts necessary for controlled stable flight. Airfoils shall be double surfaced. Plans must accompany the entry blank.

DRAWINGS: Of the actual airplane model are to be obtained from U.S. Chamber of Commerce Year Book, Aero Digest, or the Annual Directory of National Aviation. The scale to which the model is constructed shall be clearly indicated on the drawing.

SCALE: Models built to any of the following scales will be given a bonus for construction: $\frac{1}{4}$ " equals 1 ft.; $\frac{1}{2}$ " equals 1 ft.; $\frac{3}{4}$ " equals 1 ft.; and 1" equals 1 ft. Models may be built to other scales but are not desired.

PROPELLER: May be any shape, but shall have a ground clearance of 9" measured to the same scale to which the model is built. The propeller diameter shall not be greater than $\frac{1}{3}$ the wing span unless the authentic drawing call specifically for a larger propeller.

WING LOADING: Shall be at least 1 oz. (Av.) for each area unit of 50 sq.in. of effective wing area when ready to fly.

CREDIT: A maximum of 200 points may be credited to the model for construction features based on the following score:

Craftsmanship-----	50 pts.	Power plant, etc.-----	100 pts.
(Fidelity to the authentic drawing, fuselage, wings, empenage, landing gear)		Color and Finish-----	25 pts.
		Originality in indication of parts -----	25 pts.
		Total	200 pts.

A model will be disqualified in this event if the construction credits are below 100 pts. To the construction will be added the total time for three official flights.

LAUNCHING TECHNIQUE: The Model shall be launched by holding it by the tip of one wing and the propeller to prevent an initial start. The model is required to R.O.G. from a standstill under its own power.

The model has had many changes since it was built. During the initial trials the model flew normally under low power of 24 strands of 1/8. But spun while under full power of 18 strands of 1/4. Very sensitive to rudder control. Dihedral increased from 4" to 6". Spinning tendency almost removed but the model still banked steeply while under full power, and also still sensitive to rudder control. Later changes reduced the rudder area to outline as shown in dotted lines. Also a short motor trial idea was used for full power testing. The results with reduced rudder area were satisfactory, the model would almost keep level under full power. The climb was steep in a large circle. The only fault left was that the model tended to rock every once in a while.

From these tests our theory of correct rudder, dihedral and power combination seems to be substantiated. A dihedral decrease to 5" should cure the rocking. Therefore, the design may be accepted for proportions. The stabilizer area was also reduced to 33% by cutting off the tip portion. No loss of longitudinal stability noticed.

FROM HAWAII

By ROBERT FUKUDA

Model Aviation in the islands began in 1927. In that year many boys became interested due to flights of Lindbergh, Southern Cross and the Dole race. From that year till 1932 annual territorial championship contests were held, and the winners were sent to the Nationals on the mainland. During this period activities were much more intense than they are now. This was due to the fact that a local newspaper sponsored the contests, and really tried to promote model aviation down here. I, myself, belong to the "second generation" of model builders. All the old timers have "retired" or have gone to colleges on the mainland. However, there are still some old timers in the game, and they form the nucleus of our activities.

Jim, whom you met at N.Y.U., is one of these old timers, and he can tell you many things about Hawaiian model history which I don't know. You see, it was really he who taught me how to build good models. Up until then I had been building scale models mostly. He took me in hand and taught me the finer points. Unfortunately, that was in his final year in Hawaii, and I'll bet he would certainly be surprised if he could see my models now. I suppose he has told you how he and some other fellows made and flew their own primary glider.

Well, there hasn't been any great action here since the last territory wide contest in 1933. It was the last of the series started in 1927. Jimmy and his gang had their Heyday in that period. I am trying to get the "retired" old timers back again. But you know how it is when they are working. Anyway, everything got quite again after 1933 and that brings us up to 1936 when two model shops opened simultaneously. That was when gas models were beginning to get into the news. Buck Jones was here that year with a Dennyplane and interest was awakened in the gas models. Before that time of course, we had been reading about them, and one of Jim's friends built the first gas model in the islands in 1934. Our club's first model was finished early in 1937 by AhOn Au. It was a Flying Quaker powered with a Cyclone. And as we were mere beginners we flew it in February gales. Luckily, it stayed together long enough to teach us a thing or two so that our second model, a King Burd by Billy Lee had a comparatively long life. Since then, I have not tried to keep track of the models for they come so fast it would be hard to keep a record.

In April we hit our stride, and formally organized with twenty five charter members. Applied for membership in the I.G.M.A.A. and became Unit 91. In August we had our first contest, and although it was to be a club contest it turned out that there were so many outside builders that it was opened to all comers. We had 25 contestants and 35 planes. Although there was little publicity, the contest drew a large crowd and the army had to send special M.P.'s to direct the traffic. We were flying at Wheeler Field, the Army airport. As a whole, it was a successful, and we are now planning to hold another sometime in the spring.

Several unusual planes appeared. One being a twin Elf powered Martin bomber which can be seen in the Jan. or Feb. issue of Air Trails. Another twin engine plane has been built, a Sikorsky S-43. It is 7 feet in span, weighs 6½ lbs. and powered with two Mighty Midgets. It was flown off water and its builder, Rex Raymond, says it performed beautifully. It has also been flown as a landplane.

A company is putting on a scale contest. So it looks as the time is about right to start holding contests again. I am going to ask the local chapter of the Rotary Club to hold one this summer. If I am successful, may be I will be seeing you at the Nationals in two years because I'll try to get a trip to mainland as one of the prizes.

I am enclosing photos of a model scaled from Don Donahue's plans in the '37 Book by Mr. Low. The plane has proved to be very efficient and stable all four ways. It weighs about 3½ lbs. and powered with inverted Cyclone. He uses Elf coil and Penlite batteries to keep the dead weight down. Well, it is getting rather chilly now so I think I will sign off and warm my tootsies in bed. Nothing at all compared to New York's snow of course, but when one is used to going surfing in December, it does not take a very low temperature to make him shiver.

OFFICIAL LIST OF UNITED STATES MODEL AIRCRAFT RECORDS
 Approved by Contest Board of the N.A.A. March 1st. 1938

INDOOR**OUTDOOR****STICK CLASS 'A' (30 sq.in. or under)****RISE OFF GROUND**

JR: Ralph Brown	Arlington, Mass.	12m 27s
SR: Ervin Leshner	Philadelphia, Pa.	15m 47.4s
OP: Joe Matulis	Chicago, Ill.	11m 33.8s

RISE OFF WATER

JR: W.M. Hewson	Atlantic City, N.J.	7m 25s
SR: George Miccott	Allentown, Pa.	8m 5.4s
OP: Bruno Marchi	Medford, Mass.	8m 42.2s

STICK CLASS 'B' (30-100 sq.in.)**HAND LAUNCHED**

JR: John Stokes, Jr.	Huntingdon Val. Pa.	18m 12.2s
SR: Wallace Simmers	Chicago, Ill.	21m 30s
OP: Ernest A. Walen	Springfield, Mass.	18m 46.5s

RISE OFF GROUND

JR: John Stokes, Jr.	Huntingdon Val. Pa.	17m 19.3s
SR: Milton Huguélet	Chicago, Ill.	17m 36.4s
OP: Ernest A. Walen	Springfield, Mass.	17m 42.8s

RISE OFF WATER

JR: David Call	Philadelphia, Pa.	10m 41.2s
SR: Walter Lees	Philadelphia, Pa.	14m 35.4s
OP: Wm. Latour	Philadelphia, Pa.	13m 15s

STICK CLASS 'C' (100-150 sq.in.)**HAND LAUNCHED**

JR: John Stokes, Jr.	Huntingdon Val. Pa.	20m 53s
SR: Robert Jacobson	Philadelphia, Pa.	22m 29s
OP: Carl Goldberg	Chicago, Ill.	23m 29.3s

CABIN FUSELAGE CLASS 'B'**RISE OFF GROUND**

JR: John Stokes, Jr.	Huntingdon Val. Pa.	14m 15.2s
SR: Charles Heitz	Philadelphia, Pa.	13m 15.3s
OP: John Ginnetti	Atlantic City, N.J.	17m 48.6s

RISE OFF WATER

JR: Matthew Smith	Washington, D.C.	7m 50s
SR: Sidney Axelrod	Chicago, Ill.	6m 32.2s
OP: Wm. Latour	Philadelphia, Pa.	5m 42s

CABIN FUSELAGE CLASS 'C'**RISE OFF GROUND**

JR: John Stokes, Jr.	Huntingdon Val. Pa.	15m 5.6s
SR: John Haw	Philadelphia, Pa.	17m 14.8s
OP: Roy Wriston	Tulsa, Okla.	14m 44.9s

HAND LAUNCHED GLIDERS CLASS 'A'

JR: Milton Huguélet	Chicago, Ill.	44.5s
SR: Wallace Simmers	Chicago, Ill.	49.3s
OP: Carl Goldberg	Chicago, Ill.	45.4s

HAND LAUNCHED GLIDERS CLASS 'B'

JR: Robert Gelbard	Chicago, Ill.	49.2s
SR: Wallace Simmers	Chicago, Ill.	56.4s
OP: Carl Goldberg	Chicago, Ill.	47.5s

AUTOGIROS, Launching Optional, No Classes

JR: Milton Huguélet	Chicago, Ill.	4m 29.2s
SR: Richard Obarski	Chicago, Ill.	2m 26.5s
OP: Carl Goldberg	Chicago, Ill.	54s

HELICOPTERS, Launching Optional, No Classes

JR: Ralph Brown	Arlington, Mass.	2m 15.5s
SR: Richard Obarski	Chicago, Ill.	4m 35s
OP: Carl Goldberg	Chicago, Ill.	2m 46.2s

ORNTHOPTERS, Launching Optional, No Classes

JR: Milton Huguélet	Chicago, Ill.	1m 36.8s
SR: Dennis Turner	Chicago, Ill.	4m 19.2s
OP: Carl Goldberg	Chicago, Ill.	1m 18s

STICK CLASS 'C' (100/150 sq.in.)**HAND LAUNCHED**

JR: William Jackson	Hornell, N.Y.	7m 44.2s
SR: Jerry Kolb	Cleveland, Ohio	41m 15s
OP: Bernard Anderson	Akron, Ohio	12m 52s

STICK CLASS 'D' (150-300 sq.in.)**HAND LAUNCHED**

JR: Henry Falkowski	Buffalo, N.Y.	20m 11s
SR: Edward Swort	Chicago, Ill.	2m 35.5s
OP: Harry Walker	Cleveland, Ohio	36m 38.4s

CABIN FUSELAGES CLASS 'C'**RISE OFF GROUND**

JR: Wesley Peters	Akron, Ohio	16m 42.4s
SR: Wayne Pullmer	Camillus, N.Y.	41m 30.5s
OP: R.H. Bodde	Akron, Ohio	1m 51s

RISE OFF WATER

SR: Roy E. Stoner	Rockford, Ill.	1m 12s
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CABIN FUSELAGES CLASS 'D'**RISE OFF GROUND**

JR: Robert Guilfoxy	St. Louis, Mo.	1m 32s
SR: Alvie Dague, Jr.	Tulsa, Okla.	22m 1.2s
OP: Richard Korda	Cleveland, Ohio	54m 13s

RISE OFF WATER

SR: Roy E. Stoner	Rockford, Ill.	1m 13s
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GASOLINE POWERED FUSELAGES CLASS 'E'**RISE OFF GROUND (300 sq.in. and over)**

SR: Fiske Hanley	Port Warth, Tex.	50m 29s
OP: Maxwell Bassett	Philadelphia, Pa.	70m 2s

OUTDOOR GLIDERS CLASS 'B'**HAND LAUNCHED**

JR: Martin Phillips	Everett, Mass.	1m 42.8s
SR: Syd Wallerstein	Boston, Mass.	12m 57s
OP: Bruno Marchi	Medford, Mass.	46s

OUTDOOR GLIDERS CLASS 'C'**HAND LAUNCHED**

JR: Horace Smith	Jacksonville, Fla.	36s
SR: Colin Edwards	Osweg, N.Y.	6m 30.4s
OP: James McPheat, Jr.	New York, N.Y.	31.5s

TOW LINE LAUNCHED

JR: Ralph Brown	Arlington, Mass.	9m 32s
SR: Bob Fie	Columbus, Ohio	23m 13s
OP: Everett Tasker	Boston, Mass.	4m 25s

OUTDOOR GLIDERS CLASS 'D'**HAND LAUNCHED**

SR: Edward L. Smith	Jacksonville, Fla.	38s
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TOW LINE LAUNCHED

JR: Paul Durup	Boston, Mass.	57.8s
SR: Dick Everett	Elm Grove, W. Va.	2m 36s
OP: Roland Buhrig	Canastota, N.Y.	1m 18s

OUTDOOR GLIDERS CLASS 'E'**TOW LINE LAUNCHED**

SR: Jack Smith, Jr.	Dayton, Ohio	1m 23.4s
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AUTOGIROS, Launching Optional, No Classes

SR: Sanford Clevinger	Kansas City, Mo.	21.4s
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HELICOPTERS, Launching Optional, No Classes

SR: Glen O'Rourke	Boston, Mass.	15s
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ORNTHOPTERS, Launching Optional, No Classes

SR: Leonard Elgenson	Chicago, Ill.	6s
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QUALIFICATIONS: Min. Fuselage cross section area $L^2/100$. Min. weight for outdoor models is 3 oz./100 sq.in., except gliders for which the min. is 2 oz./100 sq.in. Max. Towline, 100 feet. Best flight of three trials. Delayed flights and model following by timer allowed. JR: Up to 16 years. SR: Between 16-21. OP: Over 21.

MODEL AIRPLANES NEWS

551 Fifth Avenue
New York, N.Y.

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MODEL AIRCRAFT LEAGUE OF CANADA

Junior Branch, Aviation League of Canada



JOURNAL BLDG.,
OTTAWA, CANADA

March 21, 1938

Mr. Frank Zaic
83 East 10th St.
New York, N.Y.

Dear Frank:-

Looking back over the past year, I don't think anyone could be accused of being trite in saying it was as active a twelve months as model aviation has yet passed through. The story is the same in every country where people are civilized enough to know what a model aeroplane is, and even in countries where the natives, or rather their leaders, can hardly be called civilized in times such as these. Horses, said to be uncivilized and of low intelligence compared to the human race, are not in the habit of ganging together and making war on each other, in which case we humans, models builders and a few others excepted, might place ourselves in the scale somewhere between the horse and the amoeba, perhaps in the neighborhood of the monkey. Initiating some of our worldly ambitious trouble-makers into the brotherhood of model builders might help a lot.

However, to get back to the subject, we feel that Canadians have held their own, with a little to spare, throughout this period of progress. A young man from Toronto went down to the National Meet at Detroit last year and won the open indoor stick event with the first indoor tractor he had ever built, and placed fourth in the open indoor fuselage event. Another fellow, from Galt, placed third in the senior indoor fuselage event, setting a new world record for Class B models of this type. The year 1938 marked the first occasion when interest ran sufficiently high for Canadian participation by proxy in the Wakefield International Contest. The results were not disheartening in the least; in fact, had it not been for a tough break in the way of a snapped gear shaft, one of the entries would likely have come close to bringing the famed cup to Canada. Those were the principal efforts of our modelers in international endeavour.

The high point of the model aviation year in this country was, of course, the Canadian National Contest, which was held at Toronto from August 30th to September 1st, inclusive. The number of contestants was approximately the same as last year's high of 160. Gas models completely stole the show outdoors, with rubber powered models so much in the background as to be almost curiosities. It was quite a reversal of form over the preceding year, when the gas model was the curiosity. Indoors things went well and a number of new records were established. The longest indoor flight ever recorded officially in Canada - 13 minutes 54 seconds - was made on September 1st. The fact that this time is still well under 15 minutes indicates the comparatively poor flying facilities available in this country, for as far back as 1934 a Canadian made a flight of over 17 minutes with an indoor tractor at Akron, and last

Mr. Frank Zaic

-2-

March 21, 1938

year the open stick winner referred to before flew his ship for more than 20 minutes, at Detroit. However, competition was keen in practically every event and everyone had a good time. The 1937 National Champion was Bert Norman, of Vancouver, B.C.

Club activity has kept up fairly well, although what there may be lacking in that direction isn't anything to worry about as far as the hobby as a whole is concerned. Clubs are bound to have their ups and downs, due simply to the fact that model building is so highly individualistic a pastime. The only exception to the clubs-are-bound-to-have-their-ups-and-downs rule, and a notable one, is the case of the Junior Aviation League at Boston, in my estimation, from what I've seen and heard, by long odds the most outstanding model aircraft group anywhere. There are, of course, scores of clubs in existence throughout Canada, and most of them are doing good work, but at the same time it is probably safe to say that the majority of the building and flying is carried on by the individual builder as I feel is the case in the United States.

The commercial end appears to be holding up well, which is important inasmuch as activity depends on the availability of supplies, and a model gasoline engine showing good possibilities has been developed for general sale in a mid-western city.

The best of luck and wishes to yourself and model builders everywhere,

Cordially yours,



(Edward S. Booth)
National Secretary

MODEL AIRCRAFT LEAGUE OF CANADA

OFFICIAL CANADIAN MODEL AIRCRAFT RECORDS
(Adopted by the Model Aircraft League of Canada - March 1, 1938)

INDOOR

BABY R.O.G. (30 sq. in. or under)

JR: Don McIntyre	Guelph, Ont.	7m 5s
SR: E. Houslander	Hamilton, Ont.	8m 34s
AD: Mel. Bardsley	St. Catharines, Ont.	6m 47s

STICK H.L. (30 - 150 sq. in.)

JR: Bert Norman	Vancouver, B.C.	10m 15s
SR: Harry Burrows	Toronto, Ont.	17m 14s
AD: Tom Harris	Toronto, Ont.	20m 37s

FUSELAGE R.O.G. (30 - 150 sq. in.)

JR: Clarence Dunn	Hamilton, Ont.	7m 7s
SR: Ernest Barrie	Galt, Ont.	13m 46s
AD: Tom Harris	Toronto, Ont.	11m 35s

FLYING SEMI-SCALE R.O.G. (Duration)

JR: Jim Templeton	Toronto, Ont.	2m 37s
SR: Fred Thayer	Montreal, Que.	3m 54s
AD: Albert Levy	Toronto, Ont.	4m 14s

GLIDER H.L. (30 - 100 sq. in.)

SR: Donald Gray	Vancouver, B.C.	32s
SR: Ernest Barrie	Galt, Ont.	33s
AD: Bill Doe	Vancouver, B.C.	30s

OUTDOOR

STICK H.L. (100 - 200 sq. in.)

JR: Fred Bower	Toronto, Ont.	8m 15s
SR: Ernest Barrie	Galt, Ont.	4m 20s
AD: John T. Dilly	Galt, Ont.	2m 6s

WAKEFIELD MODELS (190-210 sq. in. 8 oz. 3-Ave.)

SR: Bob Milligan	Toronto, Ont.	1m 11s
AD: Bill Doe	Vancouver, B.C.	1m 20s

GASOLINE ENGINE MODELS (1/8 oz. per lb.)

SR: Tom Smith	Winnipeg, Man.	13m 44s
AD: Don McLeod	Winnipeg, Man.	30m

JR: - Junior SR: - Senior AD: - Adult

CANADIAN AVIATION
309 Journal Bldg.
25¢ per issue, \$2.00 Yr.
U.S. \$2.50 Foreign \$3.00

1937 IN ENGLAND

By C.S.Rushbrooke
Lanc.M.A.Society

Undoubtedly 1937 will go down in history as one of the high spots in model aeronautical development. Records have been beaten in all senses, and the general progress and advancement are such as to give great satisfaction in many directions.

This year saw some of the fruits of the recent reorganisation of the S.M.A.E. and believe me, some of these were very welcome "plums". Greater attention has been paid to all-round representation, and the benefits of this has been seen in the greater activities shown by the clubs over the whole of the country. Enthusiasts are coming to realize more than ever that this is a game where the more we pull together the better it is for all concerned-and undoubtedly the intense work put in by the members of the S.M.A.E. Council is beginning to bring its just reward. Though under no compulsion to join the governing body, more and more clubs are finding the real benefit to be gained by so doing, a very healthy state of affairs.

With the weather in general in kinder mood than usually the case in these small islands, flying has been of a very high order throughout the year, and many records times have been put up. Of course, comparisons still suffer in relation to the times put up in America, but when one considers the fact that models have been kept in sight for over 12 minutes, and that without the timekeepers leaving the take-off spot - well, need more be said.

1937 saw a greater spreading out of the official events sponsored by the S.M.A.E., a move appreciated by many clubs. Honors went round very well, and there is no question that with some of the important trophy's being won by clubs outside London, a greater support for these affairs has been generated.

Social activities have received more attention, and though regarded with suspicion at first, are now eagerly anticipated by all. Anyone who has had the good fortune to attend one of the S.M.A.E. "whoopées" can bear me out when I say that this is one of the best moves made for a long time - and is doing one very good thing - the cementing and fostering of a really good feeling among all enthusiasts.

Perhaps the greatest event to take place any time and any place was the Wakefield Finals held at Faireys Aerodrome at the beginning of August. The amazing growth of this event is perhaps more marked to me than some. My first experience of this aeromodellers "Derby" was in 1933 - my first year of aeronutting- when the only competitor apart from the English team was the lone entry of Gordon Light. And what do we find in 1937 - a grand total of 11 different countries sending teams to compete for this magnificent Trophy, donated by that Guardian Angel of model aircraft - Lord Wakefield.

The details of this event are past history, but the thing that struck me most forcibly was not so much the flying as the really fine spirit of goodwill and sportmanship that prevailed. Here indeed was an object lesson for the world's statesmen - a League of Nations in all faith!! The spectacle at the Banquet following the Finals will remain one of the brightest of many memories.

Actually I was pleased to see the French Team win the Trophy. If trying has anything to do with it, these chaps certainly deserved it, as they have competed assiduously since 1934, and the improvement they showed this year was remarkable. Actually it must be a good thing for the honors to go round a bit - it would do no good if the "pot" just migrated back and forth between England and America all the time. And just think of the concrete excuse it gives us to spend a holiday in Paris! Who says there is nothing in this model game!!

Indoor flying has made itself felt in England this season, and with practise I certainly think we can show the way to a few of the worlds records. Bob Coplands flight of over 18 minutes is getting near the mark - so look to your laurels America! Facilities are none too good for this phase of the game, but more experience is being gained in the use of fairly small halls, and I am confident that 1938 will see livelier activity in this so far neglected side of the sport.

"Gas" powered models are increasing in numbers, and perhaps this section is gaining more adherents than any other. Wisely the S.M.A.E. has formulated a very reasonable but rigid set of regulation governing the flying of these buses, and great stress is being placed on the controllability of the type. The main contests for the petrol model are based on this system in preference to the super duration method, which after all depends largely on how much juice is put in the tank! A far-seeing policy is definitely required here - there being very few places where a petrol model can be safely given the air with no restrictions.

A great deal of help has been evident during the seasons from the two journals devoted exclusively to our sport. News, hints and tips and general interest matter has been given wide attention, and there is no doubt that we are feeling the benefit of the closer touch obtained through this medium.

I feel I should be neglecting my duties as Secretary to the L.M.A.S. if I did not include a bit of domestic news in this resume. 1937 has been a boom year for us, and with collaring of two of the main events of the season, e.g. the Inter-Club Farrow Shield, and the National Gliding Cup - including the breaking of the existing record for this class - we are naturally feeling quite bucked.

Our annual event, the Northern Rally, was the best yet, and is unquestionably the biggest event of its kind ever held outside London. This together with the large number of successes gained in open competition in outside events has won us a prestige second to none. But then - what Club Secretary doesn't say that about his own gang!!

And so, what do we see. A year past that contained some of the finest fixtures ever held, a governing body of such standing that it is respected and consulted wherever the game holds good, International feeling and support greater than at any other time - and all in all, a season to look back on with pride.

And to 1938 I say - you have a hard task to beat your predecessor, but it can be done. Everyone hopes to see an even greater number in Paris than at Faires, and if the representatives are like the 1937 bunch - theres nothing to worry about. Heres hoping to see Alvie, Herbie, Jesse, the Bodle-bird and Co. and to the Editor - remember there always a place at the "Rushy's" table.

THE SOCIETY OF MODEL AERONAUTICAL ENGINEERS

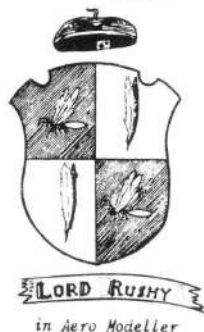
THE BODY GOVERNING MODEL AERONAUTICS
IN GREAT BRITAIN BY AGREEMENT
WITH THE ROYAL AERO CLUB

LIST OF BRITISH RECORDS

<i>Free-lance—Rising off Ground</i>	R. T. HOWSE	12. 4
<i>Free-lance—Hand Launched</i>	A. T. PUGH	21. 10
<i>Free-lance—Sea-lance—Rising off Water</i>	R. SMITH	2. 28.75
<i>Free-lance—Sea-lance—Rising off Water—Tank</i>	G. J. LEWIS	2. 10. 05
<i>Free-lance—Sea-lance—Rising off Water—Tank—Reflex</i>	J. WOODCOCK	1. 22. 01
<i>Free-lance—Robble—Rising off Ground</i>	A. H. LEE	1. 44. 4
<i>Free-lance—Robble—Hand Launched</i>	S. R. CROW	1. 22. 7
<i>Autogiro—Hand Launched</i>	S. R. CROW	10. 45
<i>Autogiro—Rising off Ground</i>	S. R. CROW	10. 4
<i>Glider—Hand Launched</i>	W. E. FAYERS	1. 10
<i>Glider—Catalpa Launched</i>	W. E. FAYERS	1. 1
<i>Farman Type (Pusher)—Hand Launched</i>	C. W. NICHOLSON	10. 7
<i>Farman Type (Pusher)—Rising off Ground</i>	C. W. NICHOLSON	10. 4
<i>Pterodactyl—Hand Launched</i>	F. B. BOLLES	1. 40
<i>Pterodactyl—Hand Launched</i>	J. C. SMITH	10. 18
<i>Free-lance—Compressed Air Engine—Rising off Ground</i>	D. A. PALLEY	1. 5
<i>Free-lance—Compressed Air Engine—Rising off Ground</i>	D. A. PALLEY	1. 10
<i>Free-lance—Rising off Ground</i>	S. R. CROW	1. 48. 11
<i>Free-lance—Hand Launched</i>	S. R. CROW	1. 47. 1
<i>Free-lance—Petrol Engine—Rising off Ground</i>	A. T. FRIGER	16. 75
<i>Free-lance—Petrol Engine—Rising off Water</i>	C. E. BOWEN	16. 4

INDOOR RECORDS—

<i>Stick—Hand Launched</i>	R. COLEMAN	15. 42
<i>Stick—Rising off Ground</i>	A. H. LEE	2. 21
<i>Free-lance—Hand Launched</i>	E. A. ROSE	4. 49



The AERO MODELLER
Allen House, Newark St.
Leicester, England
6d per Issue; 7/6 Yearly

The MODEL AEROPLANE CONSTRUCTOR
85, Manor Road
Wallington, Surrey
6d per Issue; 7/6 Yearly

NEW ZEALAND NEWS

By Vernon B. Gray

New Zealand! "Oh, that's somewhere in Australia says someone." Well, I'd like to correct such thoughts for once and for all by stating a few facts about New Zealand. (American magazines please copy.)

Fact one: New Zealand is a self-governing Dominion of the British Empire. New Zealand proper consists of three islands, North, South and Steward Islands, with a total population of approximately one and a half million. What we lack in quantity is made up with quality, ahem!

Fact two: The nearest New Zealand is to Australia is approximately 1100 miles. Also the New Zealand Model Aeroplane Association is the Official Body governing Model Aeronautics in New Zealand, not the Model Flying Club of Australia as one bright lad once would have you believe. So to all of you lads who read this enlightening epistle, the next time you hear anyone mentioning New Zealand as part of Australia just tell them to procure a 1938 Year Book and get some true knowledge for a change. Yes the geography lesson is over so let's proceed with model topics.

The sport is governed by the New Zealand Model Aeroplane Association (N.Z.M.A.A.) Clubs throughout New Zealand are affiliated to the parent Body, also the clubs are grouped into three sections known as Northern, Southern, and South Island districts, and then forward their siftings to the New Zealand M.A.A. for New Zealand recognition, thus, saving the N.Z.M.A.A. a considerable amount of unnecessary work.

The N.Z.M.A.A. handles all details concerning models that represent New Zealand in Overseas contests.

At present no "Nationals" are held in New Zealand, by this I mean that there is no assembly at one point over one or more days and flying off for champ honours. Instead the clubs hold contests, at one time of the year throughout New Zealand and the best times registered in the different classes are listed as champions of New Zealand. Altogether a hellava muddle, or as I would say "vot a system. The pick-off a team to represent New Zealand overseas is worked on the same system. Before long New Zealand Nationals should eventuate and this should give a much more satisfactory solution to championship honours.

I can only report thoroughly on the happenings in the Auckland District. I myself belong to the Auckland M.A.C. which is the oldest club in New Zealand being founded in 1928. The club is a section of the Auckland Aero Club. The parent club presents 1/4 hour dual control flights each month for competition among members of the model club. It need not be said how keen competition is when one of these flights are in the offing.

Indoor Flying

Considering the facilities here in New Zealand for indoor flying you will agree with me that the times are not so bad. The only one that lags behind is the indoor fuselage. The indoor records are held mostly by Aucklanders, due I think to the fact that, we here in Auckland have had more experience at this branch of the sport, also we've been lucky in being able to get a suitable hall. The size of the hall is approximately 40 feet high and 80 x 80 feet effective floor area. To help things to stay up a little longer, some kind person who designed the hall decided upon hanging chandeliers, so you can see that the indoor modelists' life is not a bed of roses. An amusing sidelight on indoor flying was caused when the club applied for the use of the hall, incidently, it is the Auckland Town Hall, and in the reply that was received from the Mayor, it was stated that the club would be held responsible for damage to the hall fittings, etc., by the "Toy" aeroplanes. Since then though his worship has changed his ideas on Indoor models. However, the halls in New Zealand are a little on the small side, and the trend is towards models of approximately 25" span, which would fall in your Class B category.

Outdoor

The weight ruling on outdoor models in New Zealand is 1 oz. for 50 sq. in. But we have an 8 oz. Wakefield record class also. Talking of upcurrents, well here in Auckland they make themselves conspicuous by their absence. Of outdoor flying, the boys in the country districts more than hold their own. I guess the upcurrents sure like the wide open spaces.

Concerning Petrol Models

It has been only in the last one or two years that petrol models have really taken on in big numbers. The fuel allowance is 1/16 oz. per lb. weight of plane, which is plenty to my way of thinking. The N.Z.M.A.A. has decided to put forward an Insurance & Pension scheme. Flying, however, in populated areas, etc., is definitely out with them. We here in New Zealand do not want any legislation put into force to ban petrol model flying. Therefore, it's better to be sure than sorry.

The Texas Oil Co. presented a Brown Jr. motor for competition in 1936. The contest stated that the competing clubs could use the motor if they had not one of their own, and as you can see the motor went all over New Zealand. I think the only thing that wasn't renewed were the skids that the motor was originally mounted on. I don't think the motor has finished its travels yet. The Company also gave a locally built motor for a contest this year. The contest is over and the lucky centre was the South Island Districts Association.

The most successful petrol contest to be held in Auckland to date was held on the 30th and 31st of October, 1937. There were 15 models on hand. This meet was held in conjunction for the 1937 Texaco Contest. On the 30th the contest was duration on a fuel allowance of 1/16 oz. per lb. weight of plane. The timers did not chase the models. The best time was 4m 41s, by Mr. A. Mahoney, who also holds the New Zealand record at this date. The model was definitely in the air much longer. On the 31st the Contest was a free for all, i.e., no restriction on fuel at all. This contest was run by the Northern Districts Association. Altogether three models were lost. Best time was 12m with timers staying on the spot. Before I close this survey I would like to have a little ramble through miscellaneous data, so.

All those in Auckland with flying at heart are looking forward to a regular service by Pan-American Airways to Auckland. I with many others had the pleasure to see the Sikorsky boat alight on the Auckland Harbour in March 1937.--On the question of fuel and timer control of petrol models one could write volumes, but I would like to say a few words on this thorny subject. Fuel allowance by weight of plane causes too big a distinction between large and small models. Timer restrictions sound good till you try it in contest, then it loses its spell over you. I believe that until a perfect rule is found that Melvin Yates' idea receives serious thought. I would like to see one or two classes with wing area and weight rolling in effect.--Concerning the 1937 "Moffett". It is too bad that we here in New Zealand were not notified until it was too late about the alteration in weight ruling, but we will be there in 1938.--Just a personal message to both Cahilis, great stuff, all of the best with your interest in this great sport!--Well, I guess this just about runs out my supply of information, also I'm told all good things come to an end, so to one and all the best of everything!

OFFICIAL LIST OF 1937 NEW ZEALAND RECORDS

INDOOR				OUTDOOR			
Senior Spar				Senior Spar			
H.L.	V.B.Gray	AKD	13m 13.2s	H.L.	L.R.Mayn	AKD	14m 8.2s
R.O.G.	V.B.Gray	AKD	10m 41s	R.O.G.	H.Parker	AKD	14m
R.O.W.	W.B.Mackley	AKD	4m 46.8s	R.O.W.	W.B.Mackley	AKD	1m 45s
Junior Spar				Junior Spar			
H.L.	R.E.Clarkson	AKD	6m 47.8s	H.L.	J.Curtiss	Te Aroha	14m 40s
R.O.G.	R.E.Clarkson	AKD	7m 4s	R.O.G.	R.E.Allen	AKD	5m 30.4s
R.O.W.	N.Dobson	AKD	3m 42	R.O.W.	A.Sykes	AKD	2m 49s
Senior Fuselage				Senior Fuselage			
H.L.	R.E.Allen	AKD	7m 1.6s	H.L.	N.Gray	CHCH	10m
R.O.G.	V.B.Gray	AKD	7m 7s	R.O.G.	W.C.Munro	Souhland	15m 15s
R.O.W.	W.B.Mackley	AKD	3m 26s	R.O.W.	A.J.Dacomb	CHCH	1m 30s
Junior Fuselage				Junior Fuselage			
H.L.	L.R.Mayn	AKD	4m 43s	H.L.	G.M.Perkins	AKD	18m 37s
R.O.G.	L.R.Mayn	AKD	4m 12s	R.O.G.	B.E.Loftus	AKD	9m
R.O.W.	A.Sykes	AKD	1m 31.4s	R.O.W.	W.J.Finlayson	WGTN	30s?
PETROL MODELS				Senior Glider			
Open, no restrictions.				H.L.	F.Thornley	WGTN	13m 40s
A. Mahoney	AKD		27m 6s	Tow Line J.Chinnery-Brown			
Restricted Class, 1/16 oz. per lb.				Junior Glider			
C.E.Smith	CHCH		11m 56s	H.L.	K.Vernon	AKD	10m 10s
AKD --- Auckland				Tow Line	A.Russell	Hastings	4m 21s
WGTN --- Wellington				CHCH --- Christchurch			

MODEL BUILDING IN NORWAY

by Harald W. Orvin

Model building in Norway began as early as 1911-1912 but the first model club was not started until 1921. An union of most Norwegian clubs was made in 1934. Our first National contest took place in 1935. The models were built of hardwood and were covered with silk or fabric. Best time was 33.5 seconds. In the spring of 1936 the "Allers Flying Club" was launched. It now has about 30, 000 members all over the country and the interest is still growing. The leading group is connected with the Norsk Aero Klub.

Here in Norway we have an altogether different climate from yours. Seldom do we have thermals, and up to date we had no contests with ideal weather. In the neighborhood of our great cities there are only small places to fly without 90% chance of losing the model as there are so many hills and so much wood. Under these conditions we use the average of three flights contest procedure. Our rules are similar to American. Our new models are highly efficient, having an average duration of 4 or 5 minutes in calm air or dead air as you say. We now use only balsa and tissur models. And also use high power - about 1/3 of total weight. We have tried building American models but they seem not to suit conditions under which we work.

LIST OF NORWEGIAN RECORDS
June 1937

Fuselage Models

Class C (70-100 cm span)

Hand Launched	Hans P. Grammes	29m 13s
Rise Off Ground	Per Bugge	2m 36.3s

Class D (100-150 cm span)

Hand Launched	Harald W. Orvin	2m 56.2s
Rise Off Ground	Harald W. Orvin	2m 18.4s

GASOLINE ENGINE

Rise Off Ground Henry Stub 16m 20.7s

GLIDERS

Towline Launched Harald W. Orvin 5m 36s

FUSELAGE MODELS: Min. Cross section
 $L^2/200$ —Min. weight 10 gr. per sq. dm.

OFFICIAL LIST OF GERMAN MODEL AIRCRAFT RECORDS
To JULY 1937 (from MODELLFLUG)

FUSELAGE GLIDERS

H.L.—Dis.	A. Besser	Dresden	13,500 met.
H.L.—Time	E. Bellaire	Mannheim	80m 13s
Hill—Dis.	M. Bretfeld	Hamburg	91,200 met
Hill—Time	H. Kummer	Döben	50m

TAILLESS GLIDERS

H.L.—Dis.	A. Herrmann	Nordhausen	2,375 met
H.L.—Time	K. Schmidtberg	Frankfurt/M	37m 41s
Hill—Dis.	H. Rolenda	Essen	10,400 met
Hill—Time	H. Rolenda	Essen	11m

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FUSELAGE MODELS

ROG—Dis.	A. Lippmann	Dresden	795½ met.
ROG—Time	Regimener	Dresden	13m 7s
H.L.—Dis.	R. Lippert	Dresden	22,400 met
H.L.—Time	A. Lippmann	Dresden	1 hr. 8m

Gasoline Powered MODELS

ROG—Time	A. Lippmann	Dresden	8m
H.L.—Dis.	R. Dannenfeld	Uelsen	23,900 met
H.L.—Time	R. Dannenfeld	Uelsen	52m

DER DEUTSCHE SPORTFLIEGER
 Leipzig.—50 Pf. issue

LUFT & KRAFTFAHRT

Alte Jakob Strasse 148
 BERLIN SW 68—4.4p Marks

LIST OF HOLLAND MODEL AIRCRAFT RECORDS

February 1938

Towline Gliders	A. deBoer	26m 31s
Tailless Gliders	P. Nappus	11m 3s
Rubber Models	C.H.F. van Asselt	6m 30s

Records by classification now pending.

LIST OF TASMANIAN MODEL RECORDS

Outdoor

FUSELAGE H.L.	SR: Unlim.	B. Carney	1m 15s
	SR: Wt.	B. Carney	55s
	AD: Unlim.	A.E. James	20m o/s
	AD: Wt.	F. Steven	1m 20s o/s
GLIDERS H.L.	SR:	B. Carney	1m 36s o/s
	AD:	F. Steven	45s o/s

1937 LIST OF AUSTRALIAN RECORDS

Indoor

STICK — H.L.	J. Stormont	8m 12s
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Outdoor

STICK — H.L.	J. Stormont	30m 21s
ROG	J. Fineran	4m
ROW	A. Robson	4m 37s

FUSELAGE — H.L.	S. Wiggall	20m 49s
ROG	J. Fullarton	15m 28s
ROW	H. Tonkin	4m 30s

WAKEFIELD	ROG	J. Fullarton	15m 28s
	ROW	G. Hopkins	1m 46s

SCALE — H.L.	J.C. Luke	1m 30s
ROG	J. Fullarton	1m 7s
ROW	C. Tuxford	1m 27s

GLIDERS	H.L.	J. Cavill	8m 43s
	TOW	B. Coulter	20m

Petrol Driven Unlimited Fuel
 K. Moore 39m

1937 brought two groups together. Model Flying Club and Model Aeroplane Association combined to form a National Association. Meetings now

in progress to determine By Laws and Constitution, and contest rules.—ALAN D. BROWN

INTERNATIONAL CORRESPONDENCE

There is no doubt in our mind that the enormous strides in the field of Model Aeronautics is traceable to the correspondence among the builders. It is a well known fact that no secret can be long held by a model builder, and it is a matter of days until the country knows it, and of weeks for the rest of the world to get in on it. Some of us do nothing else in the hobby but correspond about it. We are satisfied to enjoy contests on the sideline as kibitzers. Yet the eye is ever alert for something new to amaze the correspondent thousands of miles away. How to get into this special fraternity of model builders?

To be a succesful correspondent the lad must realize that it is a give and take proposition, and never to expect more then delivered. This is especially true during the first few contacts. Later on when you feel as though you knew each other for life you can bring in personal problems, but be sure that they are presented in a humorous mood. Soon the contact will grown into a desire to see each other, and if a National contest or even an International contest provides an excuse to leave home, the long distance correspondence is finally brought to a person to person

The question now is if you are qualified to begin an international correspondence. You must realize that time is valuable to most active persons and they are just the once you want to contact. If your correspondence does not reach a certain par you can only expect a polite reply or none at all. It is advisable that you be an active model builder of at least two or three year standing. You must be experimentally inclined, and have a smarming of aerodynamics. If anything new pops up, write without waiting for a reply on your last note. Never ask for any favors that will require time or expenditure of money. So keep to ideas and snapshots. Sometimes it is a splendid gesture to exchange magazine subcriptions. Above all, keep the letter in light vein, unless you both have a responsible position in the organization end.

It is simple to build up a correspondence. Just write to every national or international address that you run across and that holds possibilities. You might not reach a responsive person but you may be assured that he will turn the letter to someone else. We remember many pleasant contacts which happened just this way. The boys listed below sent their names in answer to our notice. Please do not abuse the department. Do not write unless you have something to write about. If you wish to have your name included next year, send your address to us before November 1938.

Reward for midnight oil burning? A friend in every corner of the earth. A marvelous collection of stamps. Assurance that you will be welcomed when you travel. A slow but sure grasp of the writing technic. What is a story but a long letter

INTERNATIONAL CORRESPONDENCE LIST

Leonard Becker
1657 Wyandatte Ave.
Lakewood, Ohio

Len Carpenter
212 Kensington Ave.S.
Hamilton, Ont. Canada

Lawrence Faulkner
Pleasant Hill, Mo.

Gilbert Wehrenberg
Red Bud, Illinois

V.C Gracie
"Xenia"
Southfield Rd.
Plumstead (Cape)
South Africa

P.Dalgety
c/o City Engineer
(Water Branch)
Durban, Natal
South Africa

Ben Tarnofsky
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Montreal, Canada

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Springfield, L.I., N.Y.

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Hawaii

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5322 Drake Ave.
Montreal, Canada



ORGANIZATION

Time will come when there will be three divisions of aviation organization. The Science of Model Building and Flying, Gliding and Soaring, and Power Flying. At the moment there are only two, Gliding and Soaring, and Power Flying. Each is recognized as an individual group but their cooperation is mutual. The Science of Model Building and Flying is still tied to the apron strings of the Power Flying organization. Considering that we now have a large number of builders who began to build models before 1930 we see no reason why we cannot set up organizations that will be By, For and Of model builders alone. There should be no scarcity of leaders. All we need is a start.

The first requirement is that such organization be absolutely independent from others. It must achieve an individuality of its own so that it will command attention by its own merit, rather than be an expensive step child. It cannot afford to be a little house inside the larger house. The larger house might crash and with it the little inside house. It is much better to have your house outside the walls of the larger one, and provide cooperative tunnel between the two. So no matter what happens to the big house the little house will carry on its work.

Certain countries have set up organizations that are satisfactory. Most happy and progressive are those who are given a complete freedom of activity by the AERO CLUB which is representing the FAI in that country. There is no attempt to keep the model group tied to the Aero Club. Rather, there is a mutual understanding between the two to the effect that both shall try not to do anything that will reflect on the honor of the other. It's an agreement between MEN who make every effort to stick to their part of the bargain. While in some countries we have the Aero Club most jealously keeping control of the model group through the FAI franchise. This is definitely a sign that the Aero Club considers the model group as children incapable of conducting their own affairs. It is a most exasperating feeling to be considered as a irresponsible child when some of us already answer to the call "Grampa!"

It is sad but true that the Membership of the Aero Club very seldom knows what goes on behind the scene. They are presented with a forward looking youth movement program. They approve and usually delegate full authority to one man. Then the entire structure of the model organization is kept in constant turmoil as one promotional stunt after another is tried out according to the whims of one man. All this while the many small clubs all over the land are wondering what will happen next, and wait with model work to be sure in having the model within the new rules. But rules are a minor matter. The principle grievance is they provide no distinction between the model builders and youth movement.

We feel that too much energy which could be converted into scientific research is wasted in effort to reach a compromise between model builders and the Aero Club. Why cannot it realize that progress will be so much more harmonious if we are left alone? Or should we consent to be led around by the apron strings? We are advised to break down and tag along until we become powerful enough and then break away. Sounds swell until you remember that few years from now the present leaders will give way to youngsters who have never heard about the little house outside the large house. They will simply carry on the work of the moment. If it is under the control of the Aero Club, they will know no difference. So you see how much better it would be if we begin to lay the groundwork for the future while we are still in formative period.

Give these thoughts your most careful consideration. Let your imagination roam over the possibilities of an independent organization. We have splendid examples in other fields of what can be done by youthfull and exuberant enthusiasm. Let Model Aeronautics become the Amateur Aviation and not keep it as a novelty and plaything. Let us hope that in few years from now we will have our organization in a nice white house next to a large lawn-like airport, far away from the grim and stern walls that almost hemmed us in. Then the godfathers (alias the promoters) can wander over the face of the earth without holding back the progress of the Science of Model Aeronautics!

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CONTRIBUTIONS for the 1939 YEAR BOOK will be greatly appreciated. Send in anything you may have that has a new slant. Questions often open up new fields of research. If you have special designs or contest winners which you would like to have published in the Year Book, please send a sketch before going through the trouble of drawing up plans. Drawings need not be in finished form or to any special size. Just be sure that they are clear & have complete dimensions, or drawn to some common scale.

We will be glad to enroll you in the now famous group of past contributors. A Year Book will be sent to you every year as long as they are published, if the contribution is of plan or long article variety.

EDITORS: Plans available for publication. No charge for plans so that all money goes direct to the builder.

WRITERS: Please mention Year Book when quoting whenever you are using material derived from it.

OUR SINCERE THANKS

To all who have made individual contributions to make the 1938 Year Book the best ever. Special thanks to Carl Goldberg, Ira Fralick, Elbert Weathers, Van Hattum, A. van Wymersch, J. Desnoes, F. Catter of the Modelle Air Club de France, V. Gray, Alan Brown, Sven Wentzel, Albon Cowles, Frank Ehling, and others who gathered information and plans in their vicinity. Also to John Young and Lawrence Smithline for technical proof reading. A. Mikosh for typing and correcting some of our scribblings. And to all editors who waived copyright privileges to allow us reprinting of plans, and to correspondents who by their suggestions helped to shape this book. So, until next year: "May the thermals be at your beck and call!"

Spring, 1938
New York City

Frank Zaic

ON OUR BOOKSHELF: Still have several copies of the 1937 YEAR BOOK available. \$1 Postpaid. All other editions out of print. Also **THE DESIGN & CONSTRUCTION OF FLYING MODEL AIRCRAFT**, by D. A. RUSSELL. An English book of nearly 200 pages. Of particular interest to gas model builders since explanations are based on full size aircraft formulas and theory. Price, \$1.50 Postpaid.

PUBLISHER'S NOTE: *The Editor has the honor of being an office boy, stamp lick, stenographer, secretary, filing clerk, layout man, pacifier of creditors, writer, photographer, commentator, reporter, model builder, contestant, research worker, night owl, both end candle burner, National organization politician, aeronut, world traveller, consultant, ambassador of good will, clearing house for world correspondence, draftsman, publisher, editor, and many other persons too numerous to mention but which will be supplied on demand from certain people. But he is not content with all these honors and complains of overwork and has no time to look for a paying job. He is craving for a stooge. Since the publisher has not been able to achieve the tax payer grade, and the editor keeps on editing larger and larger Year Books, and the model builder has to stint on movies to accumulate \$1.00, the price of the Year Book, the only scheme of keeping all three happy is to admit commercial advertising in the 1939 Year Book. Have you a better idea of how to bring happiness to all?*



by Fred Colbus, San Francisco
(via Weathers)

The End

This book is a reprint and its contents should be viewed from a historical viewpoint. Some of its technical and theoretical text may be outdated and misleading. — Consult current books for information on model aerodynamics. — Also, because of the long time interval between the original publication and reprint, please do not use any of the addresses shown in the book.

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