MODEL AERONAUTIC

encyclopedia vol. 2

BY FRANK ZAIC

MODEL AERONAUTIC ENCYCLOPEDIA

VOLUME TWO

Edited By

Frank Zaic

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FOREWORD

To those who may have "lost" the original 1938 YEAR BOOK, may this reprint be like a return of an old friend.

To those who may be seeing it for the first time, consider its contents as a start of your effort to add to the sum total of human knowledge on model aerodynamics.

This is a complete reprint of the 1938 Year Book with exception of model gliders and other information which will be found in the Model Glider Design.

October, 1947
New York City

Frank Zaic

PRINTED IN U.S.A.

THEORY

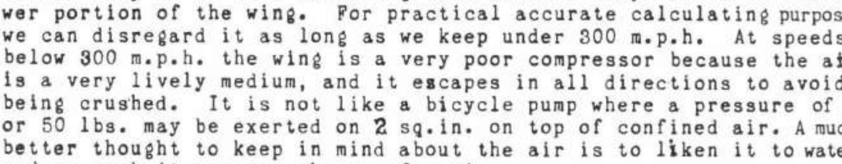
AERODYNAMICS

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 23.7 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 octupus. 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.

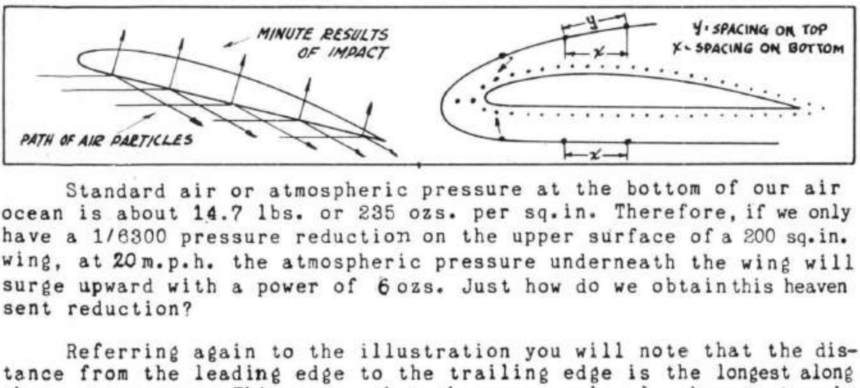
THE NATURE OF AIR FORCES ON WING

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^o. 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 x 400 = 31.00 ozs. of kinetic energy acting at a tangent of 6^o The upward component is Tangent 6^o = .105 x 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 9¾ ozs. of total lift for our 200 sq. in. wing.

(These calculations are necessarilly 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 1/6300 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 remeet 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.

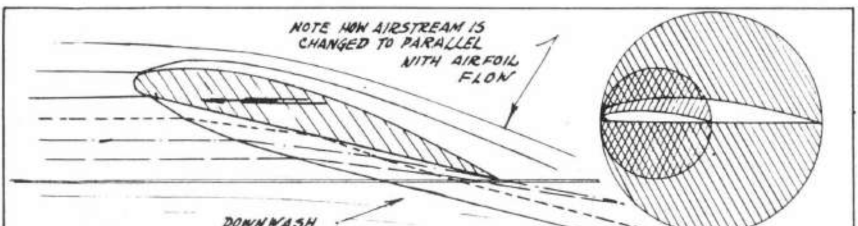
The question which always pops up is why we have the greatest difference in pressure at the leading edge, both top and bottom.

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 indueed 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 ½ 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.



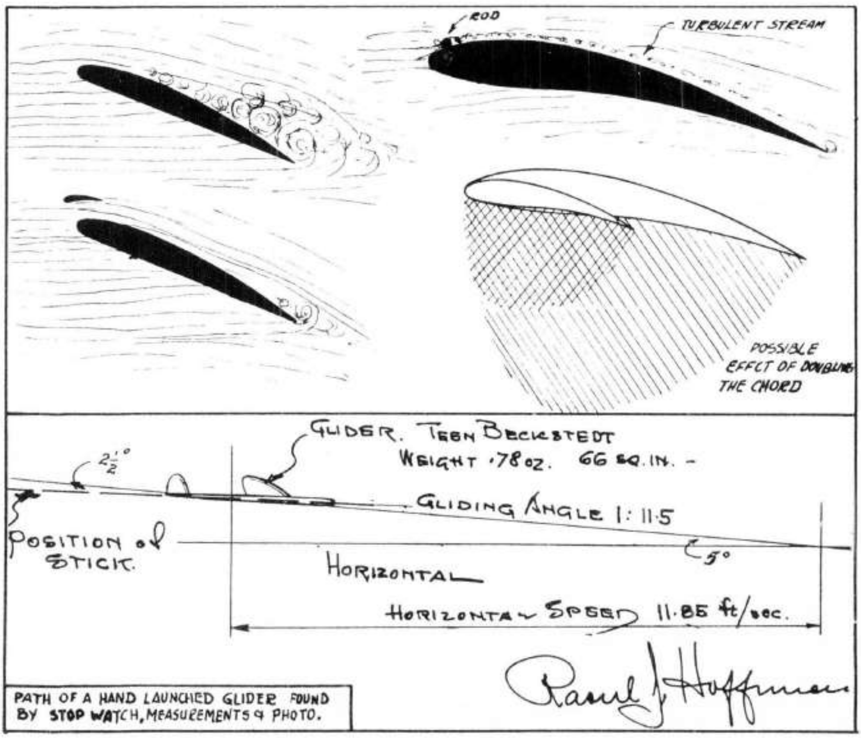
ACTION ON THE UPPER CAMBER

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 strech 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 strech. We have already seen that the greater the strech, 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 loosing 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 opposses the airline motion. This will slow down the necessary streamline flowuntil it breaks the fi-st 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 treatisewill 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 soprolonging the period in which the stagnant air does not interfere with the normal streamline flow.

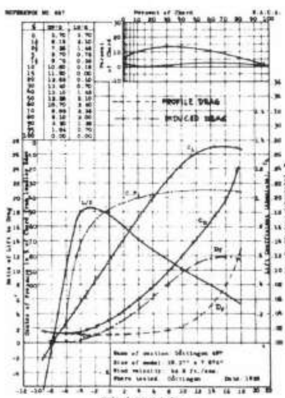


LOW SPEED AERODYNAMICS

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 resuméd 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 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

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

DRAG FORMULA

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 Gött. 497 at 2° pos. Air speed 20mph (29.33 ft.sec.)

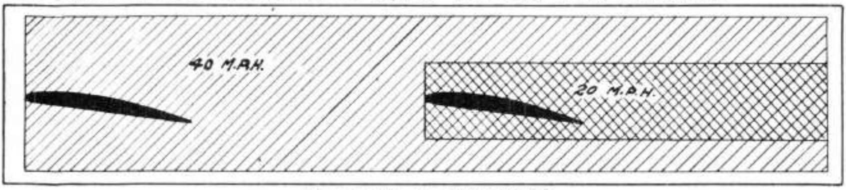
Lift $= .7 \times .001185 \times 8 \times 29.33^2$
Ans, 5.208 lbs.

Drag $= .045 \times .001185 \times 8 \times 29.33^2$
Ans. .3669 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 mocules 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 worthwile 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 ¼ 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 "streching" 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, strech 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 moleculesare 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 3½ 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 airfoils towards the tip. The airfoil with a large trailing edge downdroop 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 1½ inch steel plates. Powerful pumps can compress the air contained in it to pressures of 20 atmosphere , or 14.7 lbs./sq.in. x 20 = 294 pounds per sq. in. This increases the molecular contents 20 times, or having a 5" chord equal 100" (almost 8½ 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 ¼ 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.)

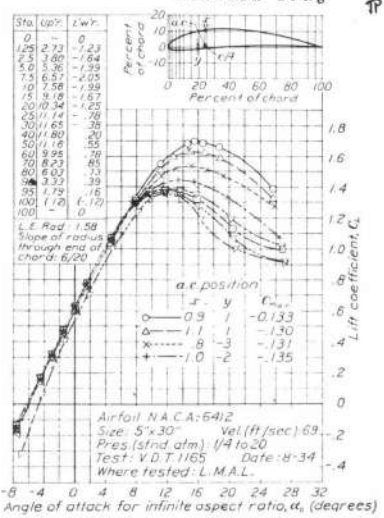
The accuracy of these tests is as fine as modern engineering permits. Every care and correction factor was applied during the run. However, the results, especially the drag and pitching moments under 800,000 Reynolds Number became relatively inaccurate owing to the limitations imposed by the sensitivity 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 coefficient and the aerodynamic-center position are considered unreliable and in most cases are not presented below an effective Reynolds Number of 800,000". All this simply means that at low speed it did not seem to make much difference what sort of an airfoil was used.

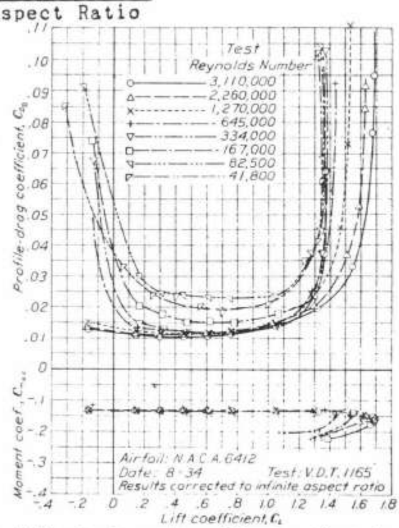
Airfoils shown herewith were chosen for their possible use in model design. Some of them have curves tested at Reynolds Number of 42,000 (very likely at ¼ atmosphere) which is equivalent of a 6 inch chord model flying at 9 m.p.h. Mr.Jacobs provided us with a simplified method for obtaining the Reynolds Number.

$$\text{Reynolds Number} = \frac{\text{Speed (Ft.per sec.) x Chord (in Ft.)}}{.000157}$$

By using this formula you can determine the Reynolds Number for your particular use. The graphs given for the tests differ from others mostly in having but only one characteristic on graph. One graph shows lift coefficients and the other the drag. The drag readings differ from standard in that it is plotted against the lift angles and also for profile drag only. An example reading: On the Airfoil No.6412, the profile drag coefficient at 6° is .025 at Reynolds Number of 41,800. Check: Lift coefficient at 6° is 1.1. drag coefficient on the 1.1. line is .025. Of course these coefficients can be used with given lift and drag formulas. However, we must not forget that the drag coefficients given are for profile drag only. To the drag calculated using coefficient from these graphs we must also add the induced drag as found from:

$$\text{Induced Drag} \quad \frac{C_L^2}{\pi \times \text{Aspect Ratio}}$$





Quoting again from the report: A"Marked scale effects that have been experimentally observed are usually associated with transition from laminar to turbulent flow in the boundary layer. This transition from laminar flow in the boundary layer, as in Reynolds classical experiment, is primarily a function of Reynolds Number but, as shown the transition is hastened by the presence of unsteadiness or turbulence in the general air stream". Turbulence in the air stream of a wind tunnel hastens the transition at a given point on the model at a Reynolds Number in the tunnel sooner than it would in free air. The effective Reynolds Number for practical purposes may be obtained by multiplying the test Reynolds Number by a factor termed as the 'Turbulence Factor'. By full scale comparison tests this was found to be 2.64.

"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 Reynold Number: Basically, the discussion is concerned mainly with the airflow 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.

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

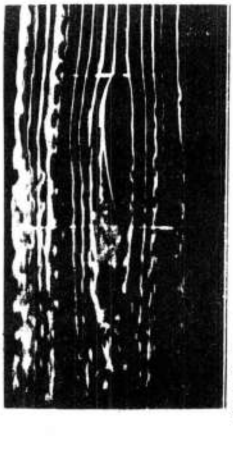


FIGURE 30.—Separation occurring on an airfoil at a low angle of attack (fig. 2) at an increased Reynolds Number.

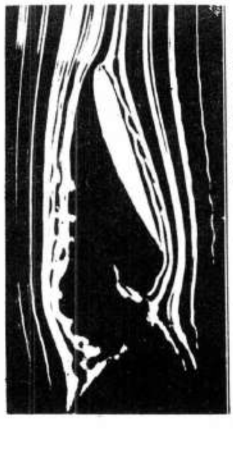


FIGURE 31.—Separation occurring on an airfoil at a high angle of attack.

"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 turbulance 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.

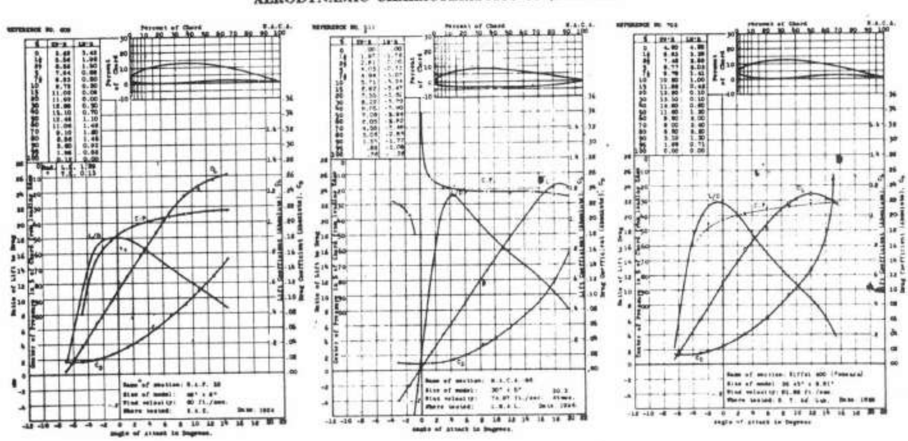
(This experiment was mostly of an illustrative nature. It will very likely not appear in print. We managed to hear of it because of a personal visit to the Langley Field N.A.C.A. Laboratories.)

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 dit 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 doen by nature. How often have we seen a model practically point down yet being sucked into the clouds! Those 15-1glides 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 theRAF 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 gues, which is as good as yours, would be to use airfoils which have the leading or entry edge of almost neutral chracteristics, 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

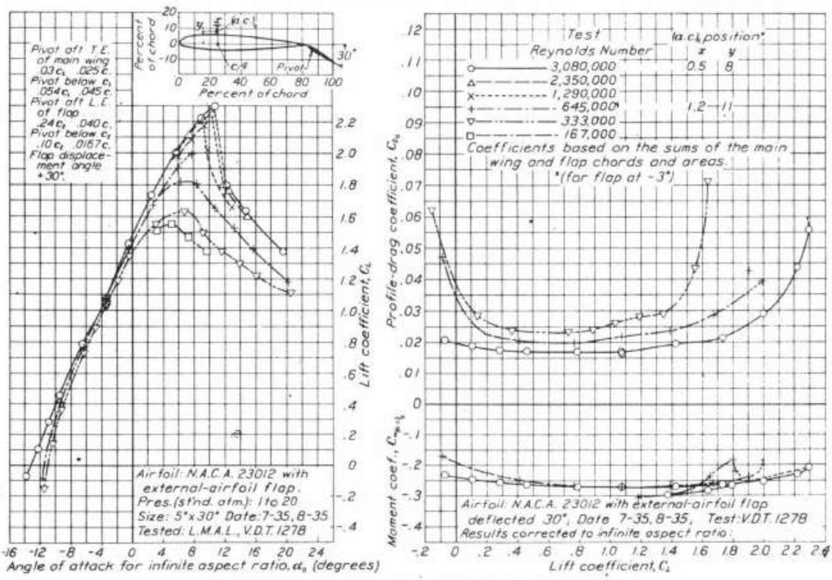


FIGURE 23.—N. A. C. A. 23012 with external-airfoil flap deflected 30°.

Main wing section........ N. A. C. A. 23012 — Main wing chord, c_1........ 0.833c — Datum chord, $c = c_1 + c_2$.
Flap section........ N. A. C. A. 23012 — Flap chord, $c_2 = 0.2c_1$........ .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.

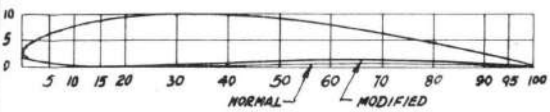
"Mr. Sullivan, Aeronautical Professor at Indiana Tech, put me next to an idea of using the complete planform of a section then dropping the rear 40% of Chord about ten degrees. The effect is that of a 40% flap permanently depressed ten degrees. The N.A.C.A. claimed at a SAE meeting that the glide was 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 hve what we could consider a sort of a glorified R F 32, 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 depresed, 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. Rauol 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 begining so that we can safely use his design.

Referring to the N.A.C.A. Airfoil 6412 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.



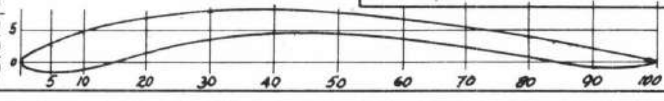
Göttingen 602

%	Upper	Lower Nor.	Lower Mod.
0	2.50	2.50	2.50
1.25	4.00	1.48	1.48
2.5	4.85	1.15	1.15
5	6.20	.75	.75
7.5	7.05	.50	.50
10	7.75	.40	.40
15	8.80	.20	.20
20	9.45	-	-
30	10.00	.05	.40
40	9.80	.15	.65
50	9.10	.25	1.00
60	8.00	.35	1.25
70	6.55	.45	1.15
80	4.75	.40	1.00
90	2.55	.30	.60
95	1.35	.20	.30
100	-	-	-

This section is used extensively on rubber and glider models, large or small. Very good results on small slow ships because of small drag increase owing to scale-effect. Concave recommended for small light models. With flat undercamber for lift stabilizers.-----Van Hattum

Marquardt S-2

%	Upper	Lower
0	0.0	0.0
5	2.35	-1.50
10	4.40	-1.00
20	6.70	1.50
30	7.80	3.50
40	8.30	4.50
50	7.90	4.50
60	6.90	3.90
70	5.60	2.60
80	3.90	.90
90	2.00	-1.00
100	0.00	0.00

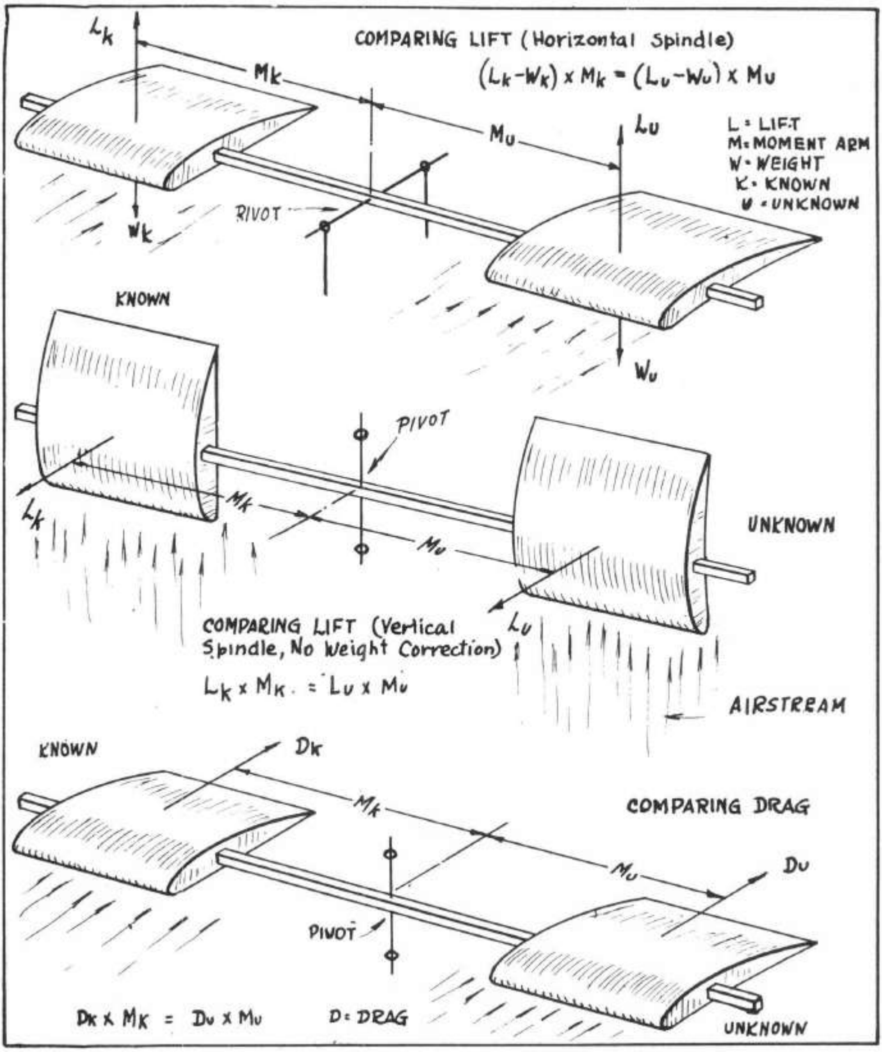


AEROBALANCE

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 Aerobalance. 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 an 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 section are in balance. The equation presented then is:

Lift of known Airfoil x its moment arm = Lift of unknown Airfoil x 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 nere 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 us. 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, althought 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, standarize 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.

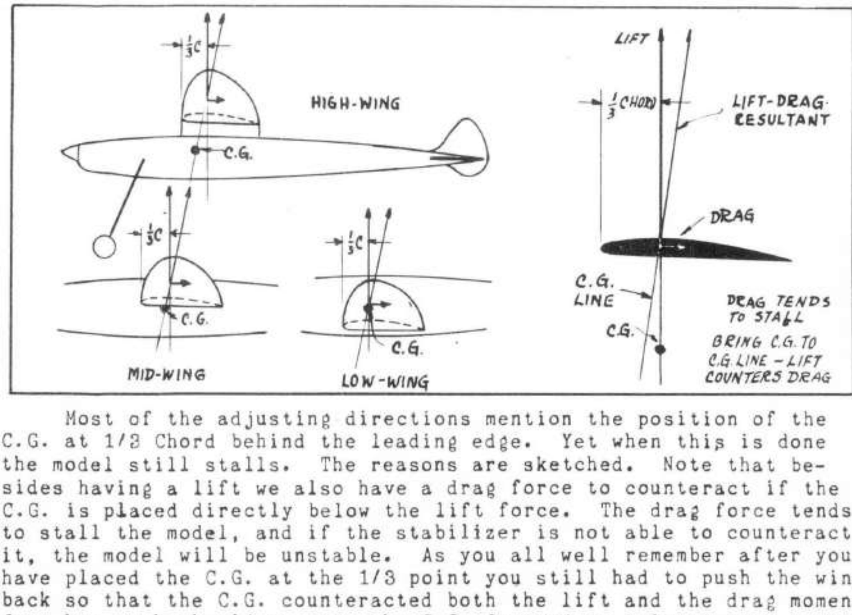
STABILITY

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 that 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 incombination.

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 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 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

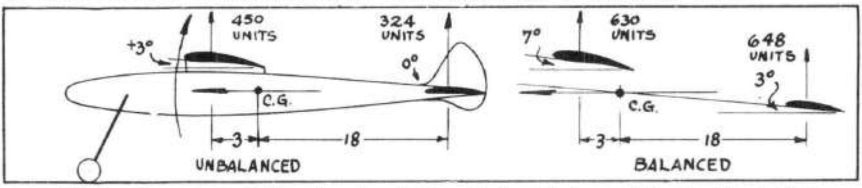
To obtain the correct resultant angle we must know the forces acting on the lift and drag lines, as well as the point through which it acts, or the Center of Pressure. Judging from experience it would seem that the L/D of a wing is about 8 at the angles of attack we use 4° to 7°. The Center of Pressure 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, 3° 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 sq. in. x .75 (coef.) x 3" = 450 units

Results for tail at -1°   60 sq. in. x .3 (coef.) x 18" = 324 units

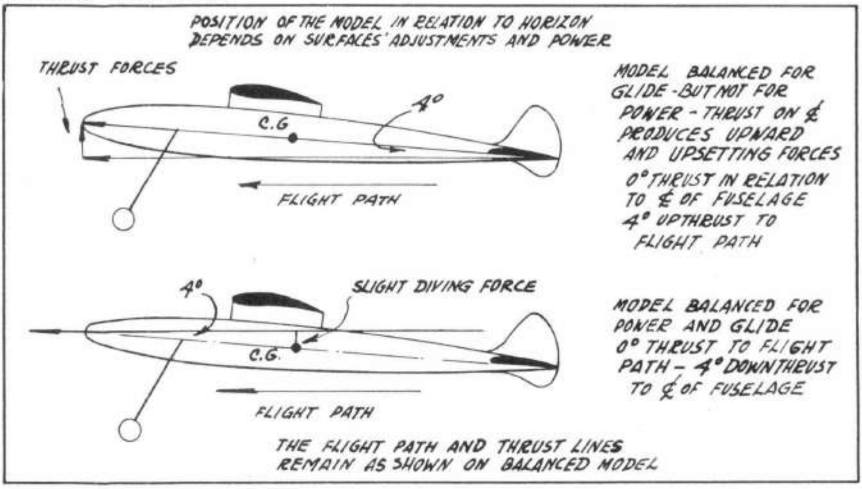
Under these conditions the wing will obviously lift the front into a larger angle of attack until a balance of forces is achieved, as:

Results for wing at 7°   200 sq. in. x 1.05 (coef.) x 3" = 630 units
Results for tail at 3°   60 sq. in. x .6 (coef.) x 18" = 648 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 6¾ ozs. and the stabilizer 1¼ 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.

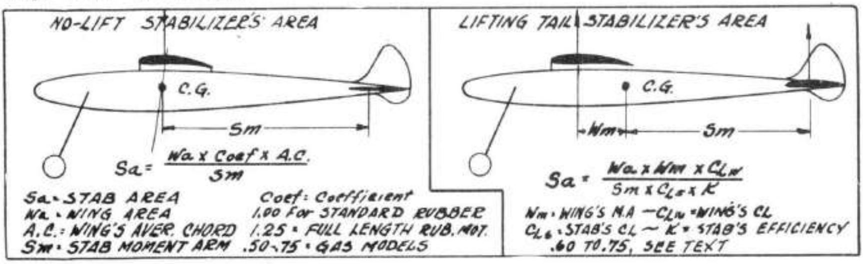
The modern method of adjusting rubber and gas models is to first adjust for the best glide, and then for the power climb. The glide adjustments are usually made by moving surfaces back and forth, increasing incidences and moving or adding weight. The final setting result is the aerodynamic balance of 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 1½" 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 forcecan 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 developed 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 enomous 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 enertia 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.

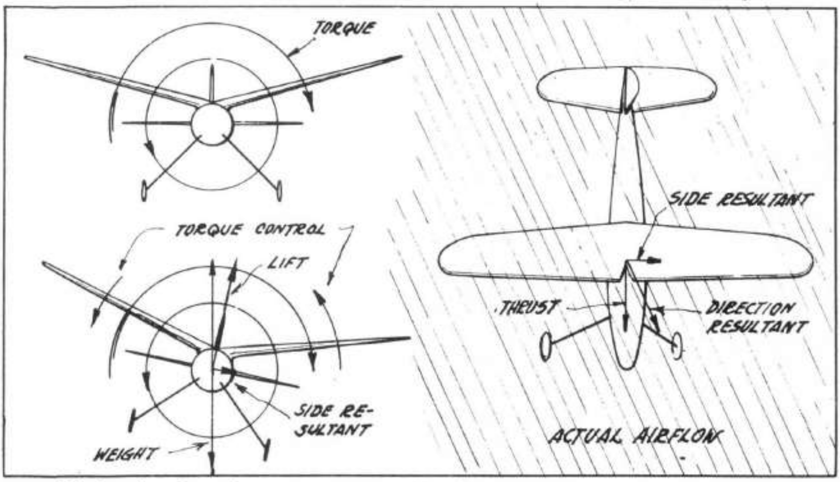
Although a lifting stabilizer is not the ideal stabilizing medium, we are forced to use it on our rubber models. So, we might as well know how to get the most out of them. When using a lifting tail the first concern is to make sure that the wing stalls before the tail if something unusual happens. The very fact that the tail works at 4^o 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

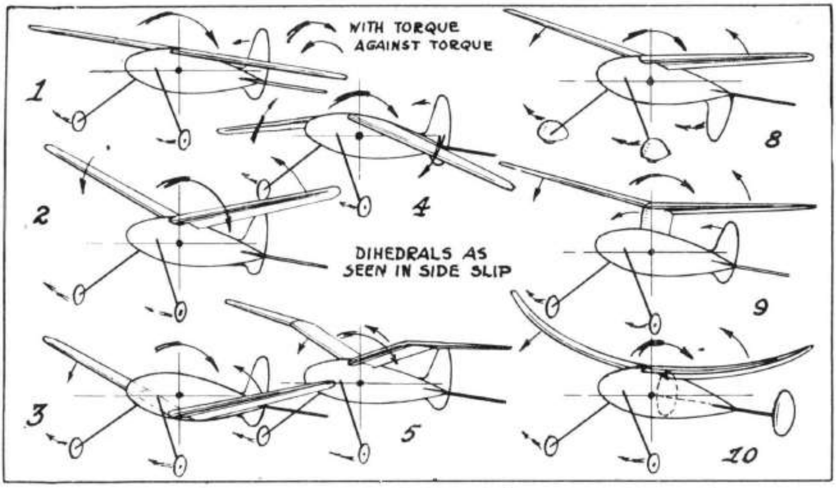
Spiral stability is a combination of Directional and Rolling Stability. It was discussed in great length in 1937, but models are still spinning in 1938 so that some of us must still have vague ideas about the matter.

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 themodel 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 flignt 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 asshown. 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 offseting its purpose.

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

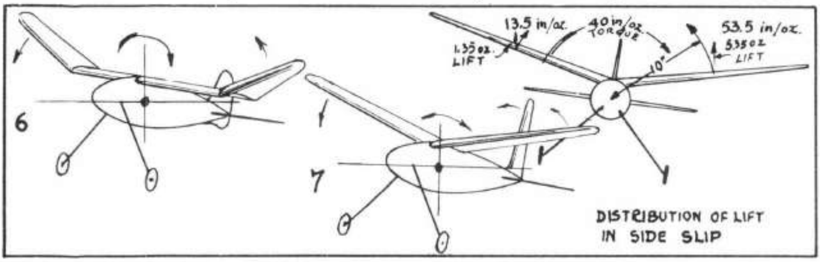
CASE #9:- Wing set on center fin. Small effect because of its short distance from C.G. Its use will call for a larger rear rudder. Might be of help on streamlined models where the fuselage has low drag and so making regular rudder too effective.

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:

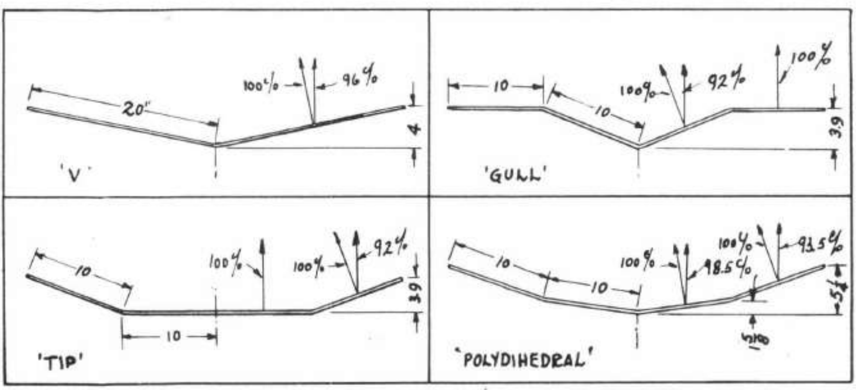
Referring back to our longitudinal stability model, we found that the 200 sq.in. wing had to carry a load of 6¾ ozs. The span of the wing is 40" and the dihedral is 4" under each tip, or 12° The torque of a tightly wound motor suitable for an 8 oz. model is roughly 40 in./ozs. Shown on the diagram, this 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.



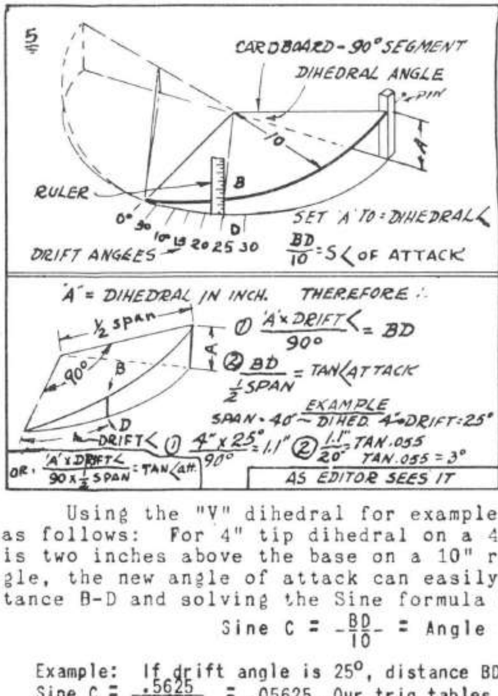
ACTION OF DIHEDRAL IN SIDE DRIFTS

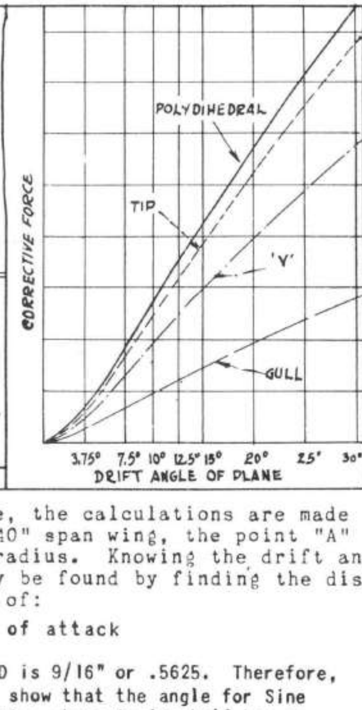
by Albon Cowles

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, 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	2½°	-2½°	.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 ¼ point of the wing half, and the tip design gets it way out at the ¾ 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 mathemathical, 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 coef ficients 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"	Angle of Attack "B"	"A" Coefs. Lift	"A" Coefs. Drag	"B" Coefs. Lift	"B" Coefs. Drag	Lift Ratio "B" to "A"
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	2¾°	-2¾°	.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

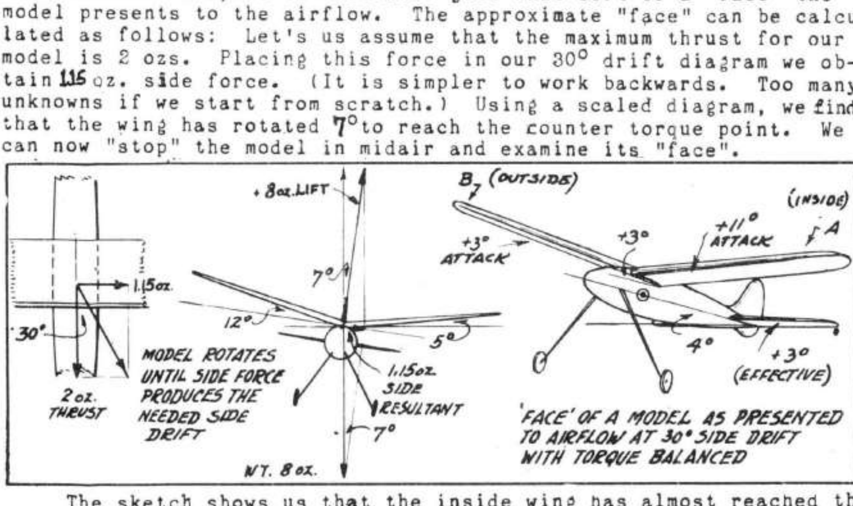
The above table shows that at a drift angle of 30° we approach our required ratio of outside and inside wing lift difference of 1 to 4. The calculations were made with the assumption that the angle of attack was 0° when the fuselage is parallel with the airflow. The lift coefficients for 4° and -4° angle of attack differences for the two halves might prove to be two small in value to produce the required counter torque forcd. 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 wing's 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 6¾ ozs. How about our longitudinal stability? Using our Longitudal Stability calculations, we have:

Results for individual wing halves,	(A)	100 sq.in. x 1.25 (11°) =	375 Units
model set at 7° Angle of Attack:	(B)	100 sq.in. X .75 (3°) =	225 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 attackshould 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 halvesshould 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.)

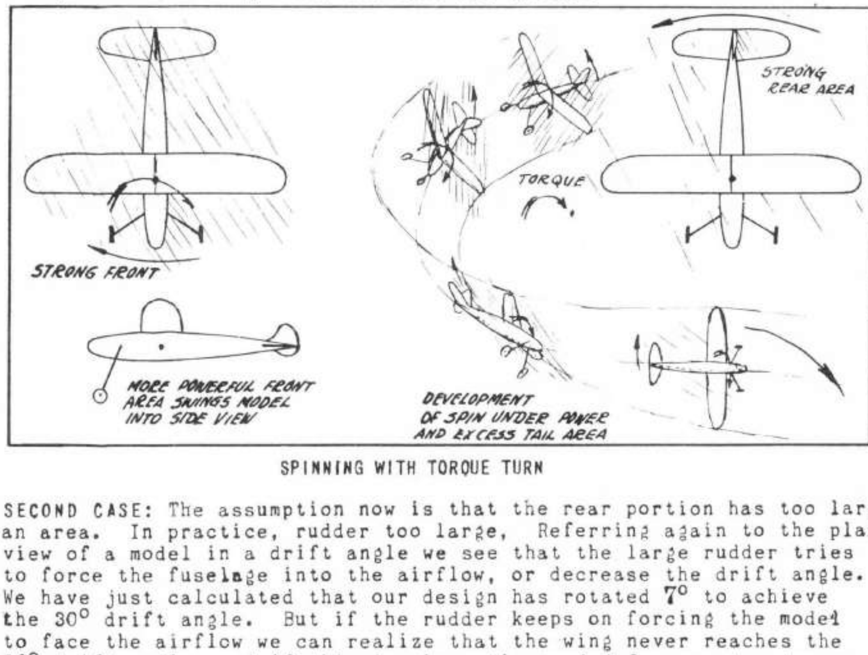
The next step is to calculate just what sort of a "face" the model presents to the airflow. The approximate "face" can be calculated as follows: Let's us assume that the maximum thrust for our model is 2 ozs. Placing this force in our 30° drift diagram we obtain 1.15 oz. side force. (It is simpler to 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".



'FACE' OF A MODEL AS PRESENTED TO AIRFLOW AT 30° SIDE DRIFT WITH TORQUE BALANCED

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 cansee 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 tailwigwags 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

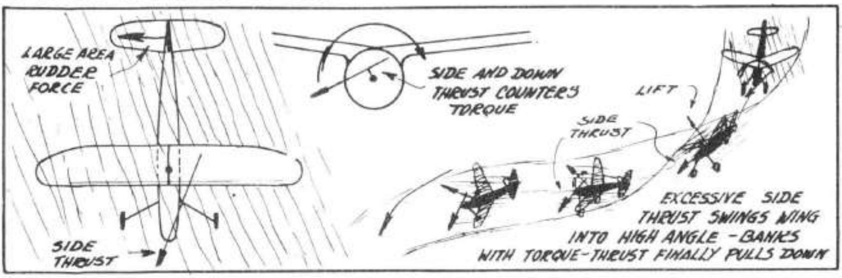
SECOND CASE: The assumption now is that the rear portion has too large an area. In practice, rudder too large, Referring again to the plan view of a model in a drift angle we see that the large rudder tries to force the fuselage into the airflow, or decrease the drift angle. We have just calculated that 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 sidewise 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.

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. Thetrouble 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 upset ting 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 WIDE AILERONS AND VARIOUS SPOILERS WITH DIFFERENT AMOUNTS OF WING DIHEDRAL

By FRED E. WEICK, HARTLEY A. SOULÉ, 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 ewhat improved. In this condition, the airplane ..s 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 (PROP TORQUE? ED.) 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.

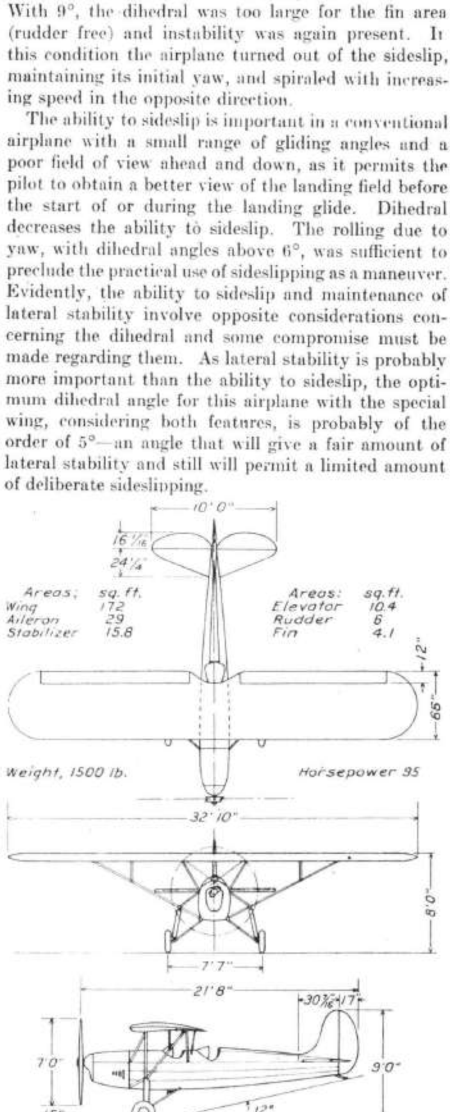


FIGURE 2.—Three-view drawing of Fairchild 22 airplane.

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 whichwould 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

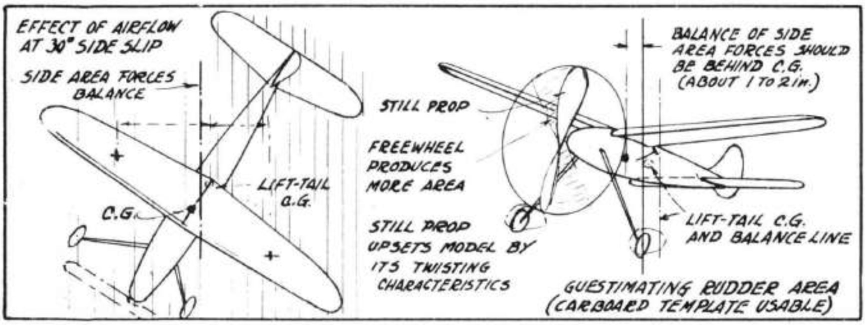
The dihedral angle can be best decided upon from past experience with models having similar prop and power; especially since a large dihedral is mostly used to counteract the torque. Or you can check on other models which proved to be stable. An 1½" for every foot of span under each tip seems to work 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 8 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 counteracting 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 reactangular 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 viewpointa 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 beatifool 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!

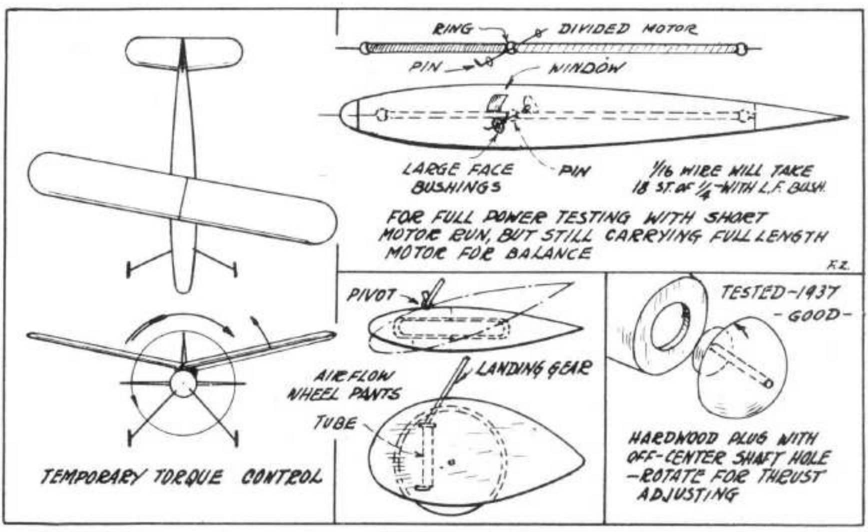
Another way of temporarily adjusting for spiral instability is to cock the wing in relation to the fuselage. In front view this will give us extra incidence to take care of the torque without bringing the rudder into play. Warping one side also helps if power is not too large. However, these adjustments 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 beauteous 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 $60,000 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.

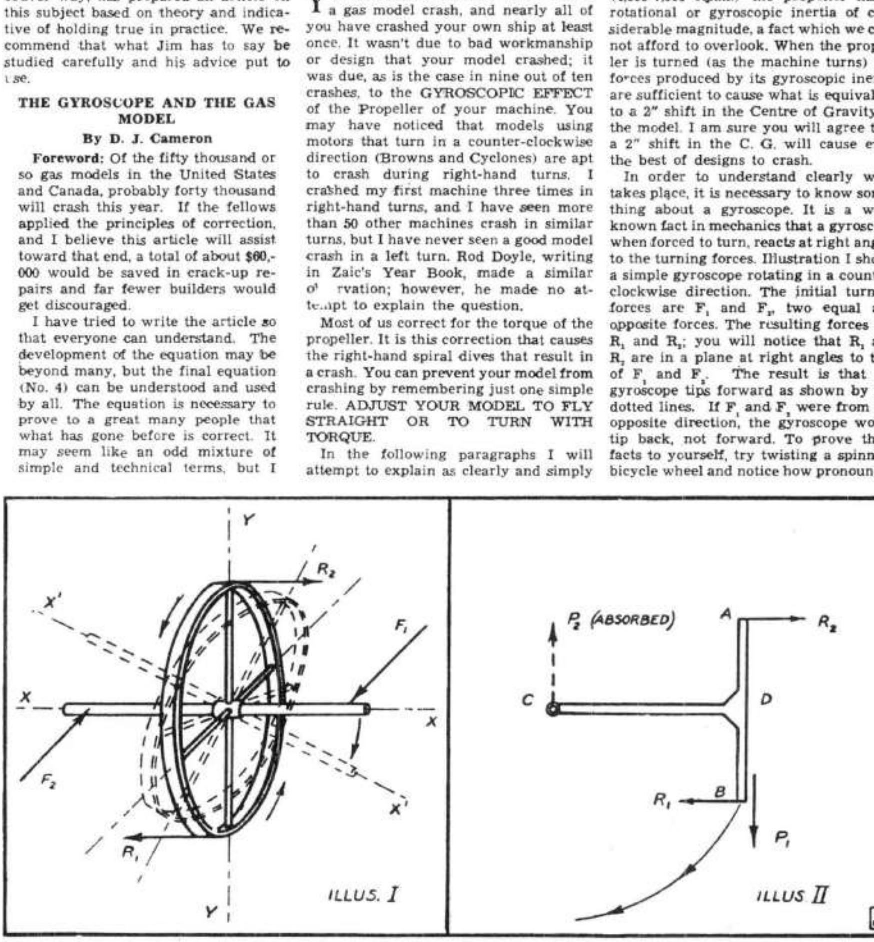
YOU Gas Model builders have all seen a gas model crash, and nearly all of you have crashed your own ship at least once. It wasn't due to bad workmanship or design that your model crashed; it was due, as is the case in nine out of ten crashes, to the GYROSCOPIC EFFECT of the Propeller of your machine. 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



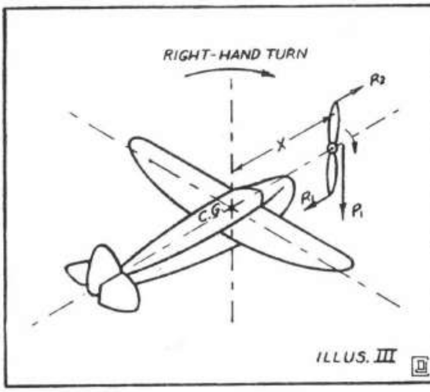
ILLUS. I

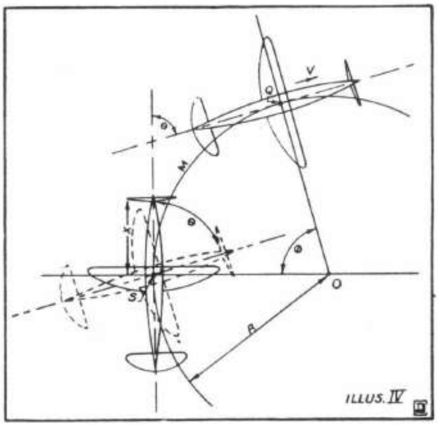
ILLUS II

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





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

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

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

θ then, is the Angular Velocity of Precession of the Airplane about the point θ, 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 x Distance of Centre of Prop. from S=P_1X.

We can say therefore, that P_1X=Reluctance of Prop. to swing about S =Moment of Inertia of Prop. about its centre x Angular Velocity of Prop. about crankshaft x Angular Velocity of Centre Line of Machine.

$$\therefore P_1X = \frac{W}{g} K^2 WW_c \quad \ldots\ldots\ldots\ldots (2)$$

where W=Angular Velocity of Propeller

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

W_c = Angular Velocity of Centre Line of Machine during turn

$$= \frac{\text{Velocity of Prop. C. G. about S}}{X}$$

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

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

$$\therefore P_1X = \frac{W}{g} K^2 \left(\frac{\pi N}{30}\right)\left(1.466\frac{V}{R}\right) \quad (3)$$

Since $K^2 = .09r^2$

$$P_1 = \frac{(.09)\ (1.466)\ (3.1416)}{(32.17)\ (30)} \left(\frac{W N V r^2}{X R}\right)$$

$$P_1 = .000429 \left(\frac{W N V r^2}{X R}\right) \ldots\ldots (4)$$

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=6,000 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)

$$P_1 = \frac{(.000429)\ (.25)\ (6000)\ (30)\ (.3396)}{(1)\ (20)}$$

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

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 diameters 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 over come 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. Reffering 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.

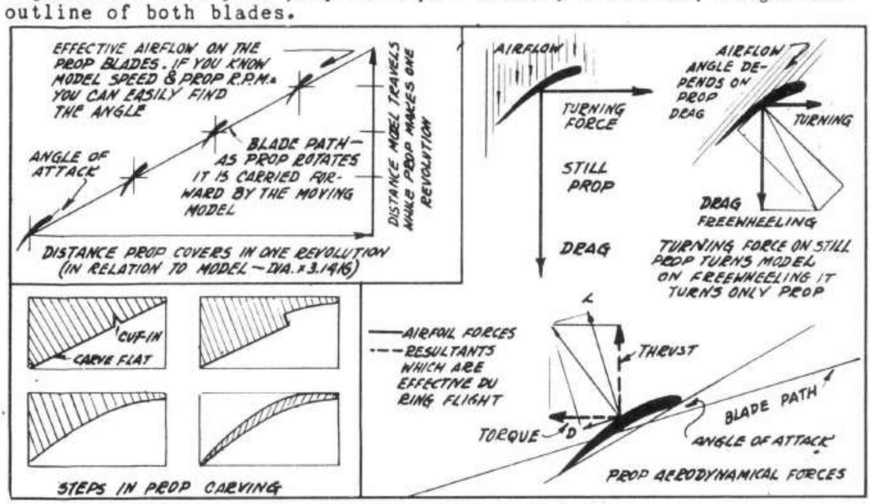
If the propeller is too small, in size or rotational speed, for the model, the blades will assume high angle of attack. And we know how high the drag is at large angles, and how closely we are flirting with stall or no thrust. On a model this is evident by high speed prop whizzz with very small forward 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 35% 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 35% 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 underccamber 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 haphazardous 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 the 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

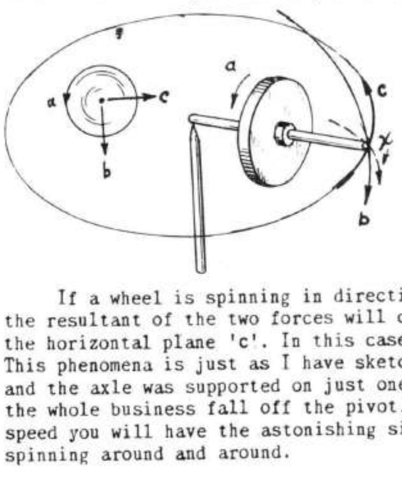
by Stanley Clurman

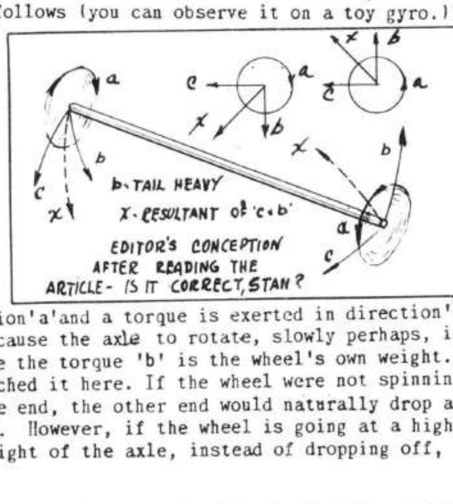
There are two general arrangements for Push-Pullers, i.e., each prop with its own power, or each prop at the opposite end of the same rubber motor. The first type seems preferable at first glance since it permits a fuselage of normal length. But it requires a special winder to wind both motors in same 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 or 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 ½ 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

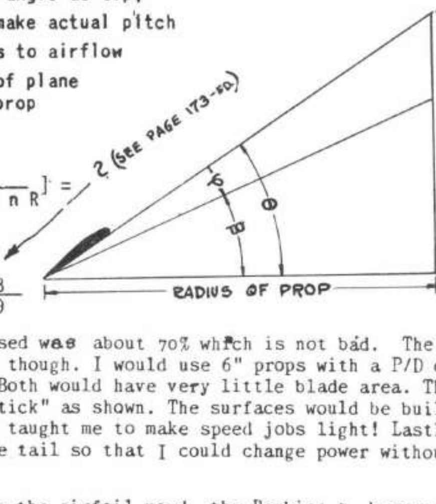
H = Theoretical pitch   V = speed of plane

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

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

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

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



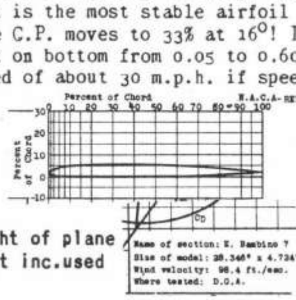
The efficiency of the props I used was about 70% which is not bad. The excessive area absorbed too much power though. I would use 6" props with a P/D of 2.0 or 7" props with a P/D of 1.8. Both would have very little blade area. The next plane would be a "flying broomstick" as shown. The surfaces would 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 Bambino 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



%	UP'R	LW'R
0	1.80	1.80
1¼	2.95	0.50
2½	3.60	0.30
5	4.30	0.00
7½	4.80	0.00
10	5.10	0.00
15	5.55	0.00
20	5.80	0.00
30	6.00	0.00
40	6.00	0.00
50	5.80	0.00
60	5.30	0.00
70	4.80	0.10
80	4.00	0.75
90	3.25	1.40
95	2.90	1.80
100	2.70	2.30

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 inrelation 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 nkt exceed a theoretical angle greater than 27^{o} at 3/4 of the diameter fromthe 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 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 x L x 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 b 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.

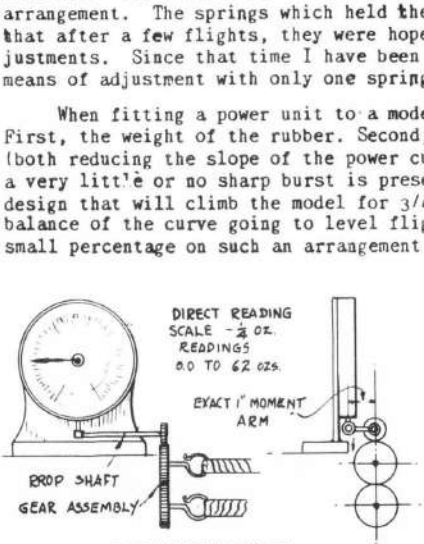
Figure 2 shows the method and equipment used for testing the torque of the motor.

The Terms **Rm** and **Rp** 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.

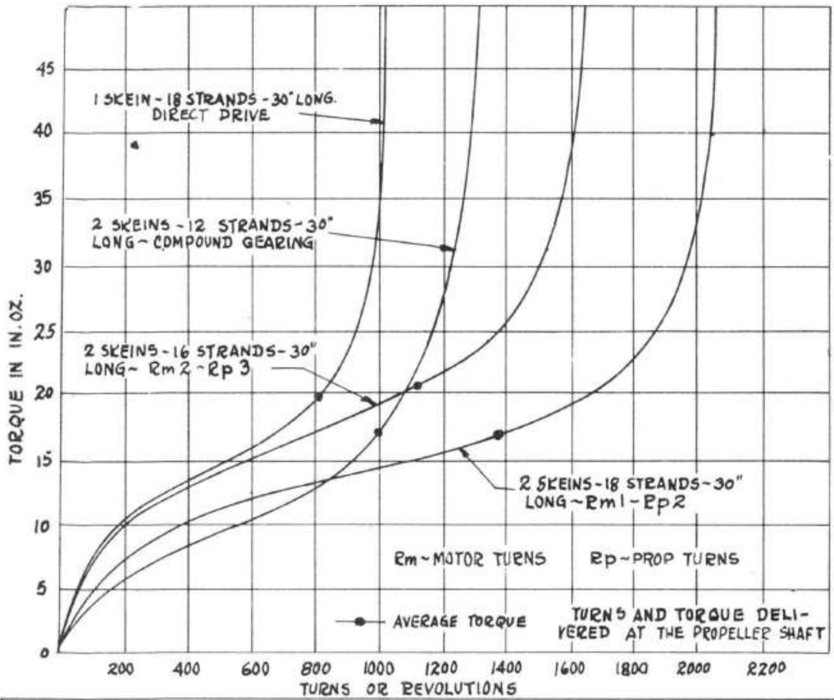
I would say that an automatic pitch adjuster would be an aid to geared motors in particular, provided, of course, it really worked. I have been working on such a device for 2 years, which would just give the thrust required for a predetermined performance of the particular model. About a year ago, I 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.

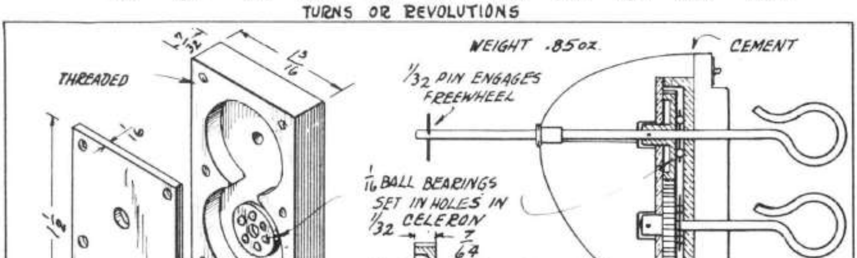
When fitting a power unit to a model, rubber should first be considered. First, the weight of the rubber. Second; the length of motor or proper gearing (both reducing the slope of the power curve) to reduce the power curve to where a very little or no sharp burst is present on the top end. Third; a propeller 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.

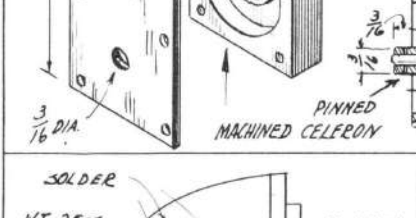


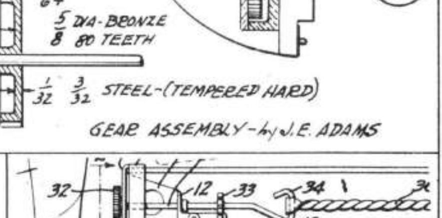
TESTING EQUIPTMENT

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.


1 SKEIN - 18 STRANDS - 30" LONG. DIRECT DRIVE
2 SKEINS - 12 STRANDS - 30" LONG - COMPOUND GEARING
2 SKEINS - 16 STRANDS - 30" LONG - Rm 2 - Rp 3
2 SKEINS - 18 STRANDS - 30" LONG - Rm 1 - Rp 2
Rm - MOTOR TURNS
Rp - PROP TURNS
AVERAGE TORQUE
TURNS AND TORQUE DELIVERED AT THE PROPELLER SHAFT
TORQUE IN IN. OZ.
TURNS OR REVOLUTIONS
0
5
10
15
20
25
30
35
40
45
200
400
600
800
1000
1200
1400
1600
1800
2000
2200


THREADED
3/16 DIA.
MACHINED CELERON
WEIGHT .85 oz.
CEMENT
1/32 PIN ENGAGES FREEWHEEL
1/16 BALL BEARINGS SET IN HOLES IN 1/32 CELERON
5/8 DIA-BRONZE 80 TEETH
STEEL-(TEMPERED HARD)
PINNED
GEAR ASSEMBLY - by J.E. ADAMS


SOLDER
WT. .35 oz.
10 TEETH
40 TEETH
1/16 SHAFTS
1/32 BRASS
by L. FAULKNER


SLIDING IDLER
RELEASE
SLOT
FREEWHEEL
PATENT NO. 1,936,072 - INVENTOR H.L. RODERICK

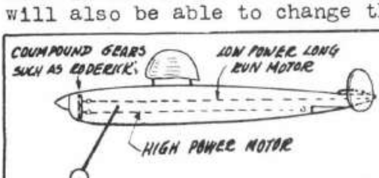
OUTDOOR MODELS

Reports from the field would have us believe that the rubber models are losing out to the gas jobs. We are sure this is only a momentary pause because with the engines at the present low price all of us want to have a try at the gas jobs. And as soon as the boys find out that the troubles begin after the gas model has been build, we are sure they will swing right back again to rubber powered models with which the fun begins as soon as the model is finished. How many of you have seen a gas man pouring out sweat trying to start the engine, look up enviously at a snappy and high climbing rubber job. You can just hear him sigh as he goes back to his work.

It is believed that eventually it will be required of all model builders to demonstrate their ability with rubber powered models before they are granted a gas model license. Under the present set-up it is not unusual to have a man start with a gas model kit without a slightest knowledge of aerodynamics and adjusting procedure. Under such conditions the hobby becomes expensive as well as dangerous. Of course, if you are satisfied to be a chaufeur to a kit job, you are welcome to spent your days with gas jobs. But remember that it takes brains to get the utmost out of a rubber powered model.

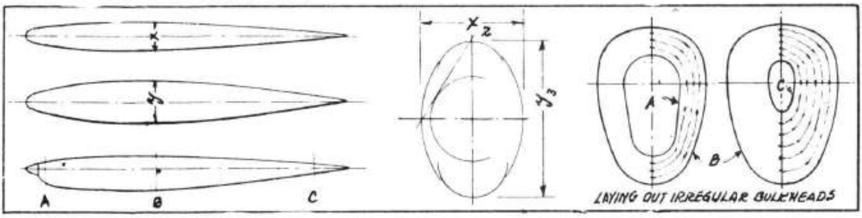
The plans disclose almost every conceivable type of construction. According to the theory we should be definitely convinced that streamlining and elimination of protruding parts is the order of the day. Our idea of an ideal job is as follows: Fuselage of streamline planform and of round cross section. The prop to be blended into a spinner, folded or perfectly freewheeled or have it idle for a long time by an auxiliary motor. Landing gear might as well be fixed for 1938 until a simple and fool proof retraction idea is found. The wing should have an elliptical or polydihedral with fair outline. Aspect Ratio of about 7. It should be mounted about ½" above the fuselage. The tail section of fairly low aspect ratio stabilizer flanked with twin rudders. Twin rudders will increase the effectiveness of the stabilizer and have it approach the Reynolds Number of the wing. Their total area should be very slightly more than that of a single rudder.

The model just pictured should present no difficulties to build. Although the fuselage might be a bit out of ordinary for some of you. The mounting of the wing above the fuselage should be done without the usual cage like construction. It is simple to predetermine the C. G. position, and with that fixed the wing mount can be made to just fit, or it can be even countersunk into the wing and covered with cellophane tape. To predetermine the C.G. just take the center of the rubber motor. You may be sure that the C.G. will be plus or minus 1" from this point. Why? Take an 18 strand, 3/16 rubber, motor, 36" long which included 10" slack. When this motor is wound, every inch of it will weigh .09 oz. Now move the C.G. point ahead or behind the center of the motor. 1" change will produce .16 oz. at an end of a 13" M.A. With motor having so much influence on the C.G. position, you might as well use it as thedeterming factor for locating the C.G. Then you will also be able to change the rubber without change in adjustments.



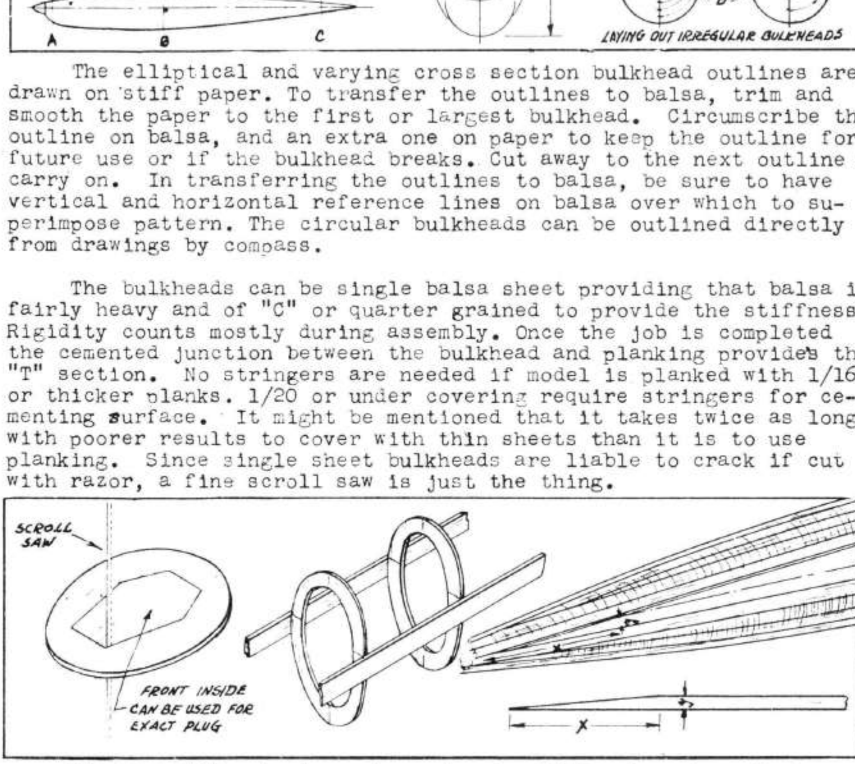
EFFECT OF RUBBER MOTOR ON THE POSITION OF C.G.

Perhaps a more complete discription of how to go about in construction of monocoque fuselages might entice more of you to build them. The First Step: Decide on the cross section shape. Round is best. If you need room for two motors, use elliptical. If you want 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.



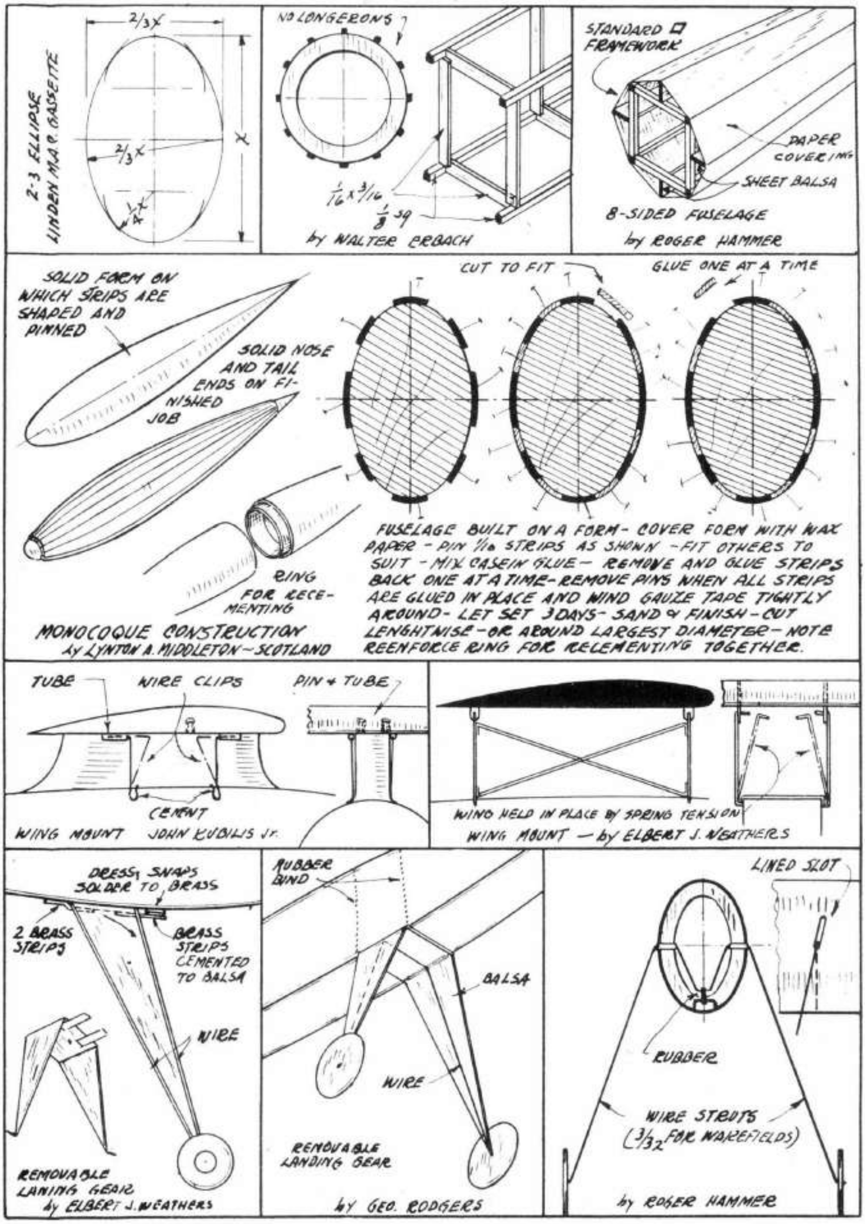
The elliptical and varying cross section bulkhead outlines are drawn on stiff paper. To transfer the outlines to balsa, trim and smooth the paper to the first or largest bulkhead. Circumscribe the outline on balsa, and an extra one on paper to keep the outline for future use or if the bulkhead breaks. 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.

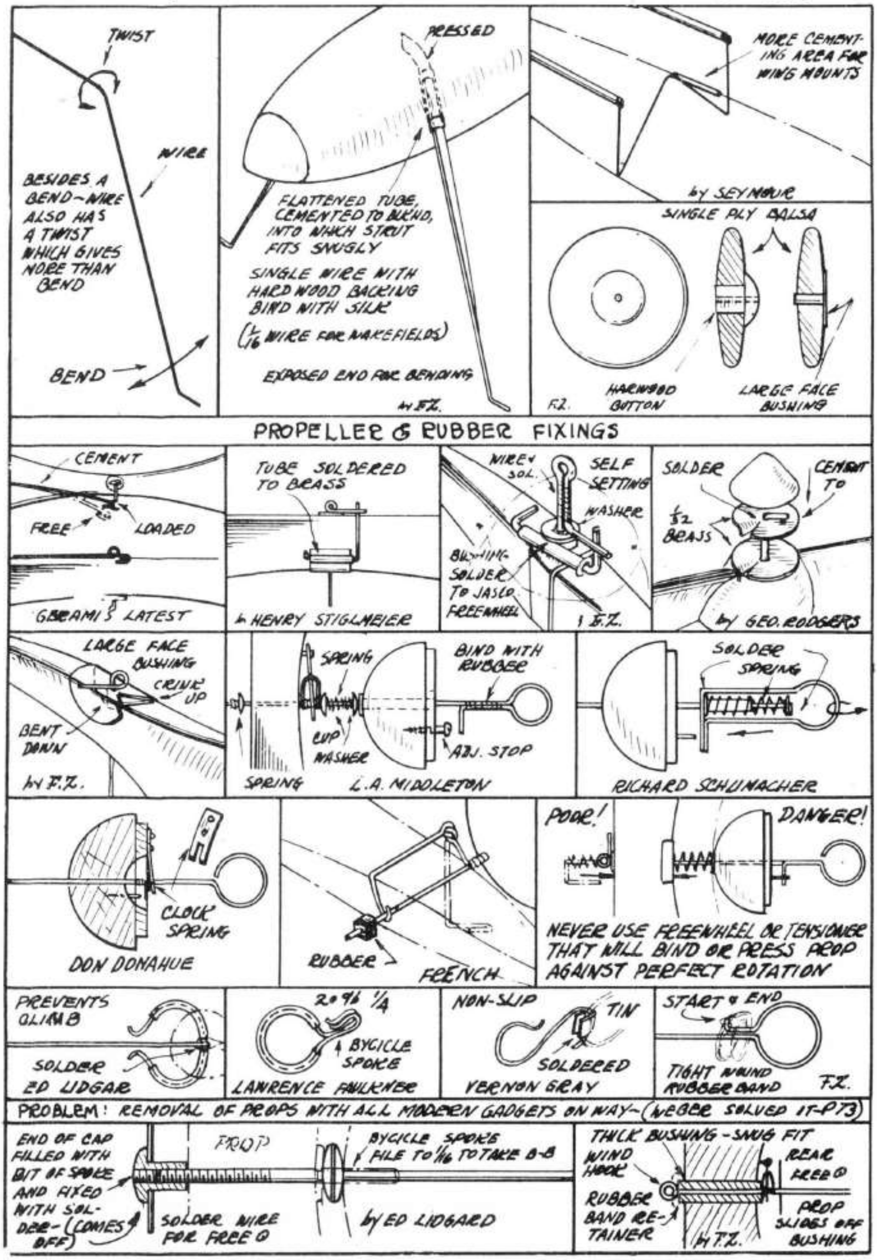


The assembling is begun by using two 1/16 x ½ master planks on which the bulkheads spacing are marked. (2" spacing seems about the maximum allowable.) Tack to the strips with cement the two bulkheads which are on either side of the largest. Be careful in doing this as it forms the base for the entire 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 ligth 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 prefered 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, but 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.

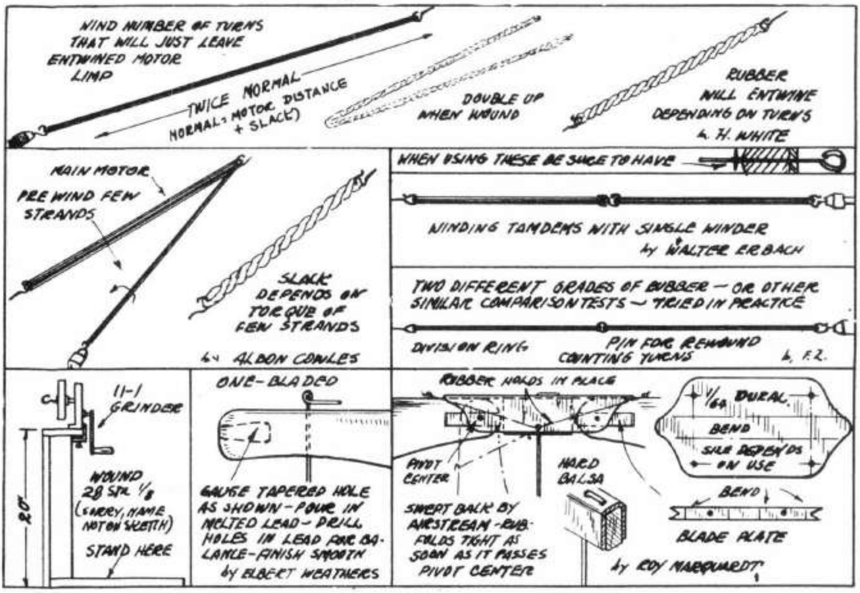


INHERENT RUBBER TENSIONERS: The original was developed by H.White of the Nothern Heights M.F.C.,London. The idea is sketched below. The initial turns are critical as they decide the tightness of the entwined motor. Used extensively in England. ---Bob Copland

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 tamdem. --Walter Erbach.

TESTING DIFFERENT GRADES OF RUBBER: Wind the two grades in tamdem. 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	.0011411	.0016932	.0019756	.0021576	.0028220	.0033864	.0043152

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

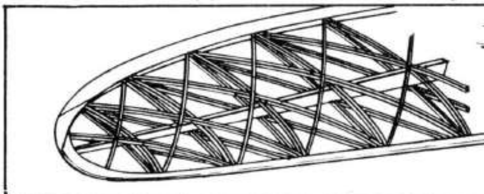
No.Str.	4	6	8	10	12	14	16	18	20
1/8	80	64	55	50	44	40	36	34	32
5/32	68	59	50	46	41	38	34	29	24
3/16	60	54	46	42	38	35	32	27	24
1/4	56	44	37	33	29	27	25	23	21

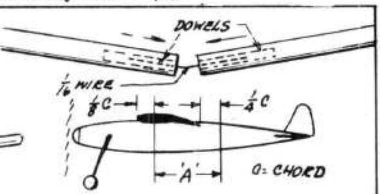
GEODETIC CONSTRUCTION

by Roy Marquardt

Two years ago British Enginners brought a sensational new developement 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 2/3rd 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 fuselage 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 bank models it consists in taking 3/16" birch dowels and drilling the ends to take a 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 1½". The 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
W : total weight of model, gr
S ; Span of main wing, cm
M : motor torque, mmgr
n : propeller speed, r.p.m.
s ; propeller slip, %
T : propeller thrust, gr
P : propeller pitch, cm
D : Propeller Diameter, cm
B : max. propeller blade width, cm
v : model flying speed, m per sec.
q : specific main wing loading, gr per sqdm
N : number of winding turns
L : original skein length, cm
C : total rubber weight, gr
(spec. gravity : 0.9

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

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

Rubber torque ------ $M_{mean} = 9\sqrt{R^3}$ mmgr -------- $M_{max} = 20\sqrt{R^3}$ 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) $N_{first} = 65 \frac{L}{\sqrt{R}}$ $N_{final} = 80 \frac{L}{\sqrt{R}}$

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

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

(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}	$130 \frac{C}{W}$	$900 \frac{C}{W q}$	$1525 \frac{C}{W q}$	$1850 \frac{C}{W q}$
Pmax.	$105 \frac{C}{W}$	$1200 \frac{C}{W q}$	$1650 \frac{C}{W q}$	$1900 \frac{C}{W q}$

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 thinkkthat 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 7½% 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 posibility of engine trouble made this particular arrangement of engines undesirable.

WINGS

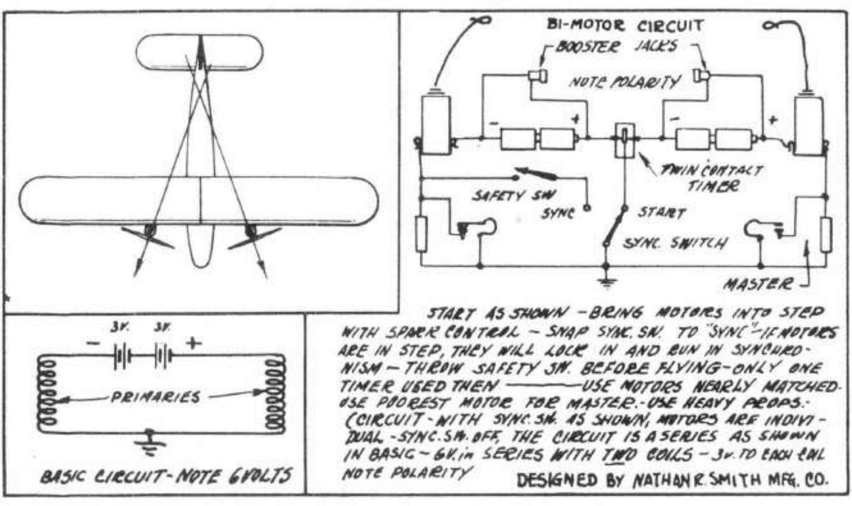
by Dick Everett

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's letter, ED.) Another design is the single spartype 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 trong but the sga 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.



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:

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

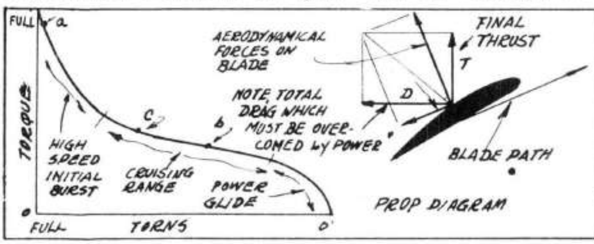
The following calculations are based on 1 strand of 1/8 x 1/30 Brown Rubber as a unit of Area (A), and on 'K' whose value was found to be 163 when using Brown Rubber. Our turn formula (good only for Brown Rubber, T56,) is as follows:

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

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.



VALUE FOR $\frac{3}{2}$ POWER - BASED ON 1/8 RUBBER. (SLIDE RULE FIGURES)		
$(STR^{\frac{3}{2}})$	$(STR^{\frac{3}{2}})$	$(STR^{\frac{3}{2}})$
2 = 2.83	16 = 64	30 = 165
4 = 8.	18 = 76	32 = 182
6 = 14.7	20 = 89	34 = 200
8 = 22.6	22 = 104	36 = 218
10 = 31.6	24 = 119	38 = 240
12 = 41.5	26 = 131	40 = 254
14 = 52	28 = 148	42 = 270
FOR OTHER SIZES USE EQUIVALENT 2 STR. 1/16 USE 1 of 1/8 * 10 STR. 1/4 USE 20 STR.		

TORQUE

Basic Torque Formula ——— $\text{Torque} = K(\sqrt{A})^3$ 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 2π x 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:

Work per revolution $= .4 \times (10)^{\frac{3}{2}} = .4 \times (31.6) = 12.65$ 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 tighly 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 1/3 oz. the pull will 38" ine 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 if 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 launching height of 16 feet, the L/D is about 6. If the plane weighs 2 oz. the drag is 1/3 oz. For 8 oz. model the drag is 1 1/3 oz. Actual Pitch is found by:

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

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

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.

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: $\text{H.P.} = \frac{\text{Drag x Velocity or Speed}}{375}$

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 comple 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.

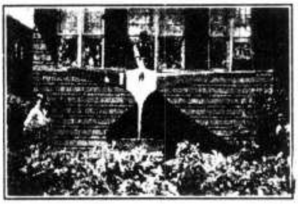
Cocensus of opinion on wing construction is for standard framework with silk covering. Also that color doping should be thin to allow light to show through the covering for better visibility. Airfoil Göttingen 497 seems to be the favorite now. Inspection of the plans and their performace should give 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.

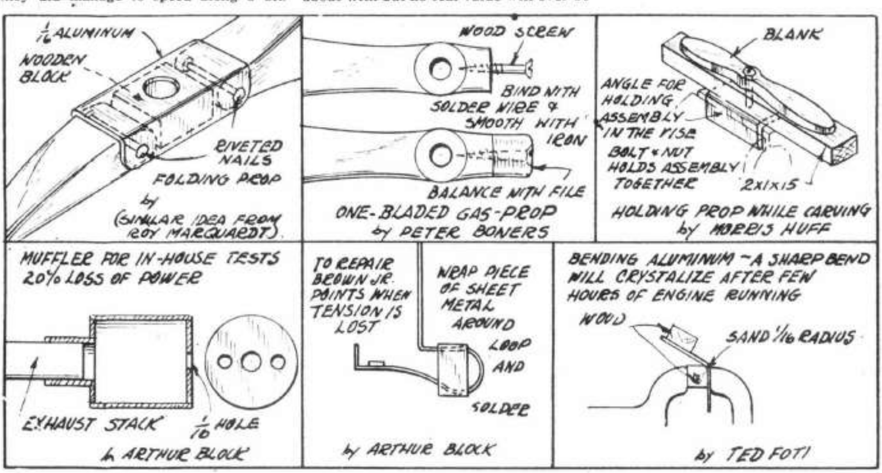
Here also is where the single has it over the standard prop. Due to the small profile shape it is practically impossible to get both blades identical. With the single this is not necessary and so a statically and dynamically balanced prop is more easily obtained. Nevertheless profile shape is important. 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.

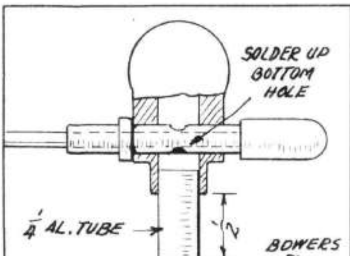


LAMINATED BULKHEADS: CASCO Casein glue is best for 3-ply gas model bulkheads. Of course the 2 in. wide sheets are cemented with cellulose cement edge to edge. The the plys are joined with CASCO. It is excellent for large surface balsa joints such as leading edge splices on gas models. CASCO does not 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.

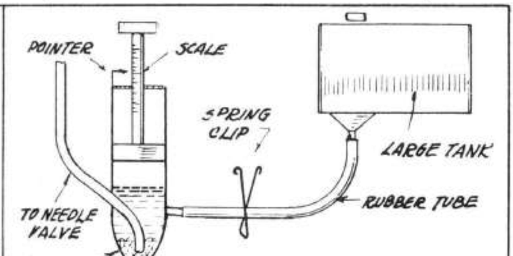
FOR TYING PARTS with rubber on gas jobs, use strips of inner tube cut spirally under water with scissors. This rubber is less affected by light and air. It streches enough for most uses.--Curtis Janke

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

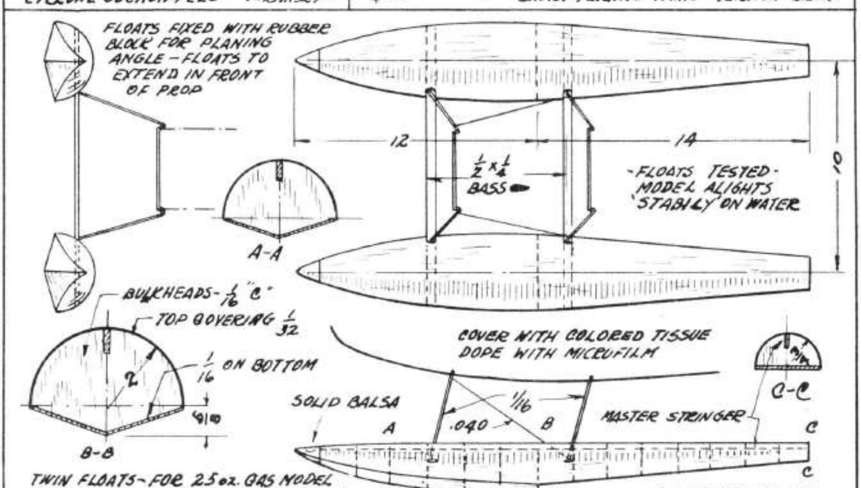
ANOTHER MAN with same idea. "I have had it on my motor for 5 months and if you shut your eyes and start the motor you would think it was a Brown.--From now on always mount the gas tank below the level of the intake and you can forget about turning the needle off. The motor will run on same needle adjustments."----Clement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



CYCLONE SUCTION FEED



SHORT FLIGHTS TANK -VERNON GREY

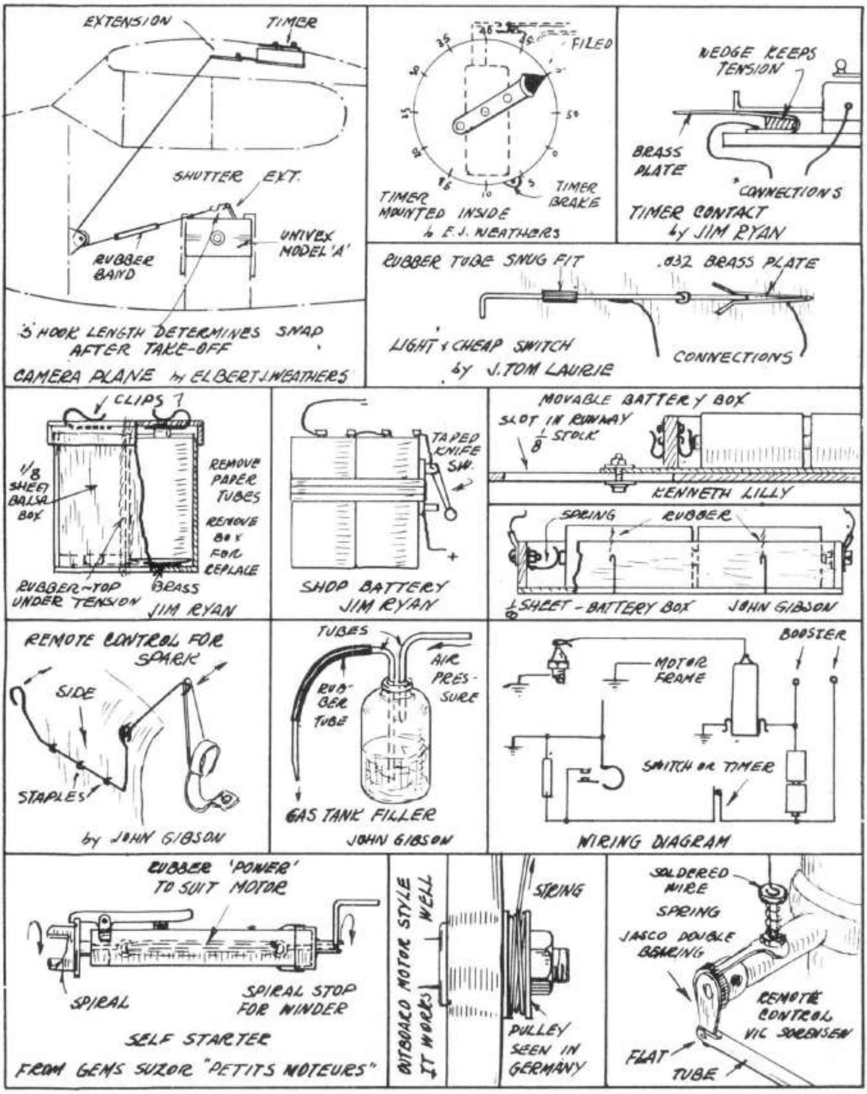


TWIN FLOATS-FOR 25 oz. GAS MODEL (350-400 sq.in NO TAIL FLOAT NEEDED)

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.



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 Zepplin 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: Drag = .00256 (drag area) X (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: Drag Area = 1.28 (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 cowled, 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.

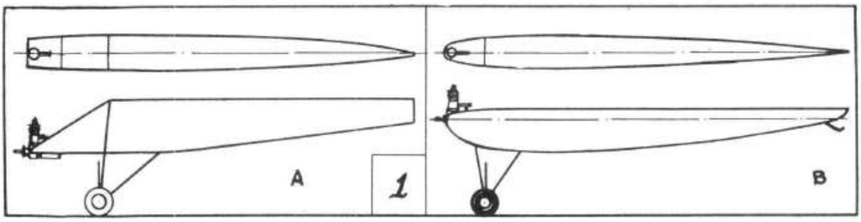
Fig. 2. Is a graphic illustration of the drag found in terms of equivalent flat plate area, in both square centimeters and in square inches, of the A &B models with and without landing gear and wheels.

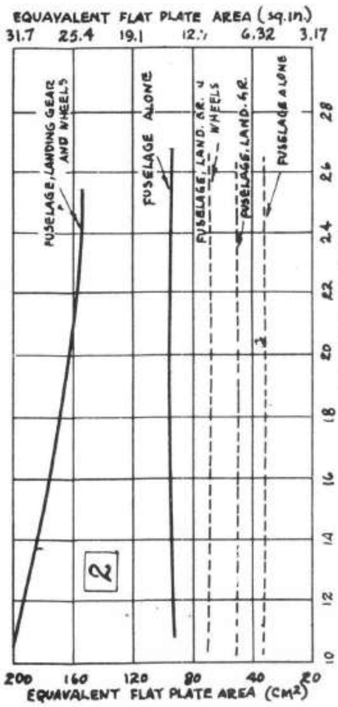
Fig. 3. Is also a graph of the drag found for the two models with and without landing gear and wheels as given in the actual amount recorded in the instru ment in grams at various speeds.

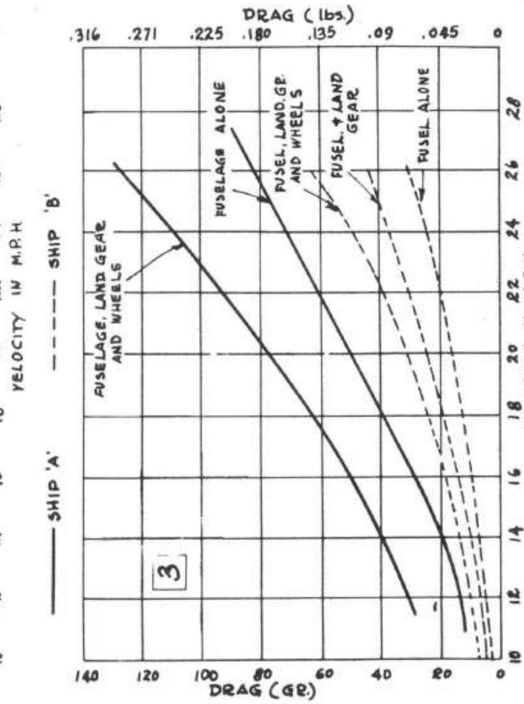
If one looks over these various charts you can get a good idea of what a little streamlining will do for the reduction of drag. The comparison of A and B in Fig.3 should be proof enough that streamlining is a sure step in the right direction. At the speed of 24 m.p.h. the ship "B" has only 1/2 the drag 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. $\frac{DV}{375}$ = **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 maby "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.







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 if 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 succesful 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.

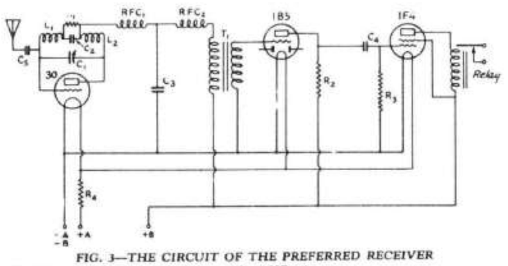
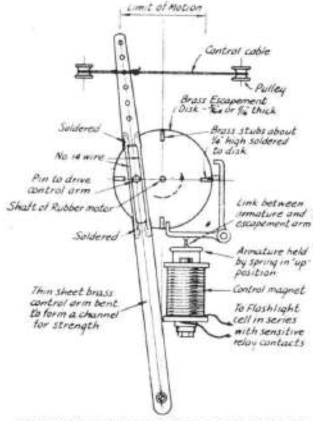


FIG. 3—THE CIRCUIT OF THE PREFERRED RECEIVER

C_1—17.5-μμfd. midget variable (Hammarlund HF-15).
C_2—100-μμfd. fixed condenser.
C_3—0.01-μfd. fixed mica.
C_4—0.01-μfd. fixed paper.
C_5—M-30 National mica padding condenser, with the upper plate bent at right angle to the lower.
R_1—1 or 2-megohm grid leak.
R_2—150,000-ohm, ½-watt fixed resistor.
R_3—2-megohm, ½-watt fixed resistor.
R_4—5-ohm fixed resistor.
RFC_1—Ohmite u.h.f. choke.
RFC_2—Bud 125 millihenry choke.
L_1, L_2—Each 4 turns No. 14 wire, ½-inch diameter.
T_1—Any very small audio transformer. The one originally used is a push-pull affair with the whole secondary 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 thing, 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 develoomcnt 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.

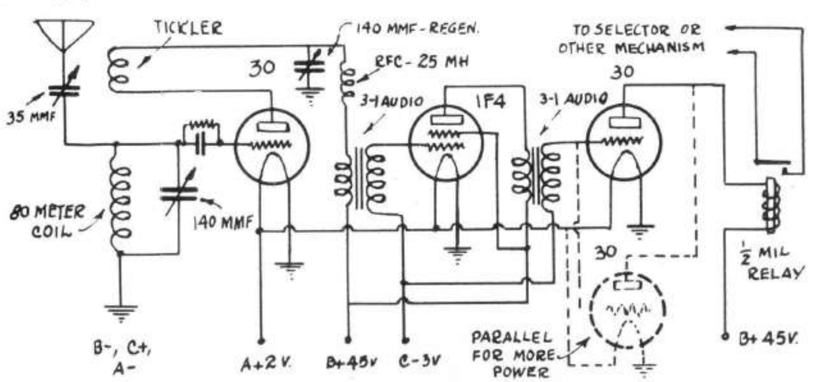
The circuit selector is most important or "brains" of the whole control system. It is of the resonant reed type. In this circuit selector the control signal is fed into a coil which is wound on a transformer core that has an air gap cut into it. Across this air gap there are mounted six steel reeds. 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 reversable 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 weighted 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.

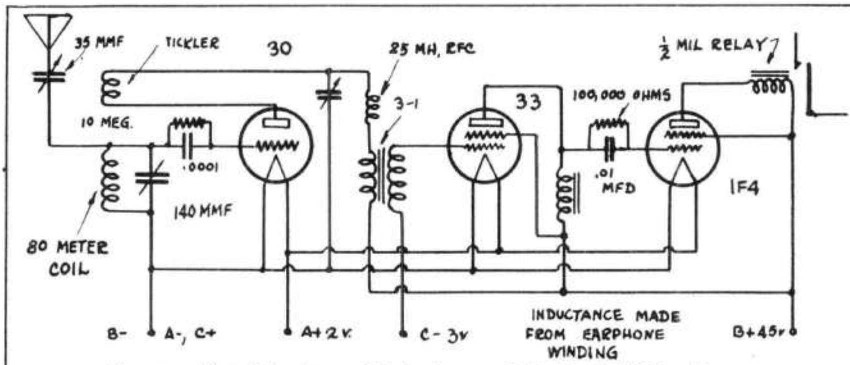
RADIO CONTROL CIRCUITS

By Chester Lanzo

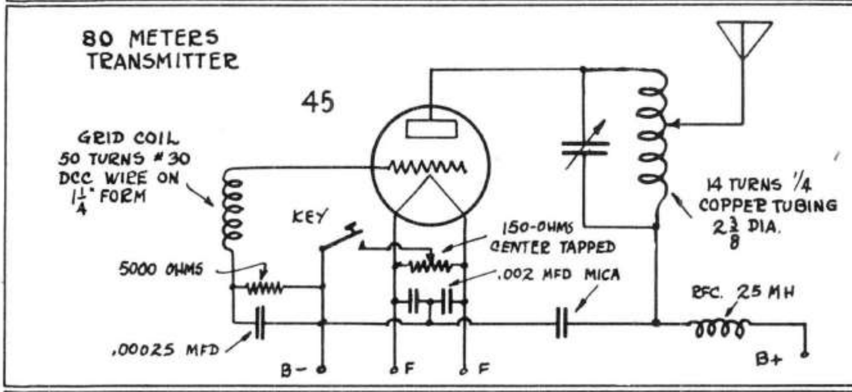
I have drawn a group of different types of radio control apparatus for the experimentally inclined radio control enthusiast. I cannot say which is the best receiver as each has its advantages and disadvantages; experiment alone will tell.

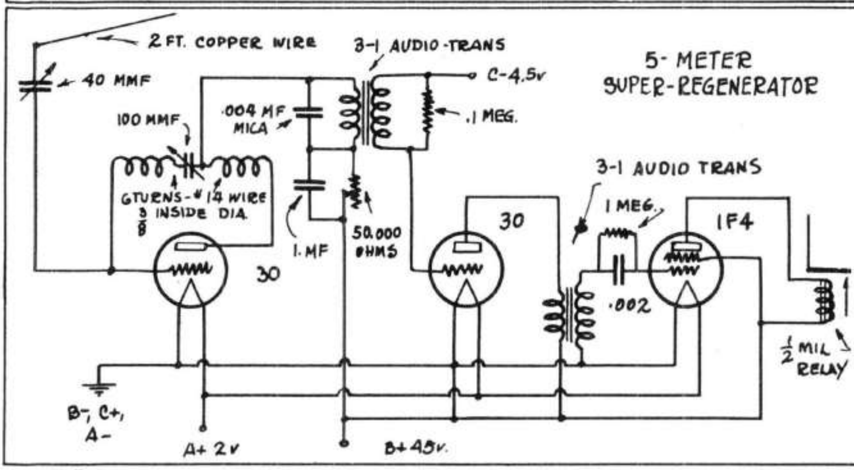


I seem to have most success with this type of receiver using the 80 Meter Band. I will switch to the 160 Meter Band as I think more consistant results will be obtained.



Regenerative-Detector with 2 stages of Audio Amplification

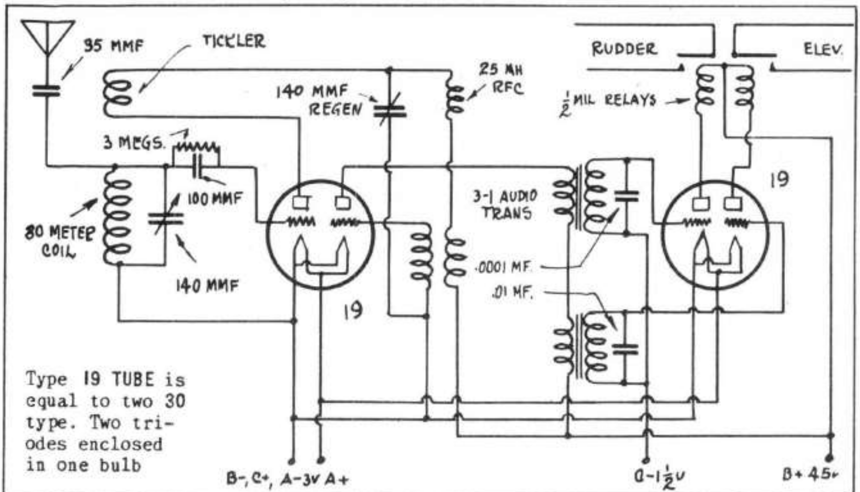


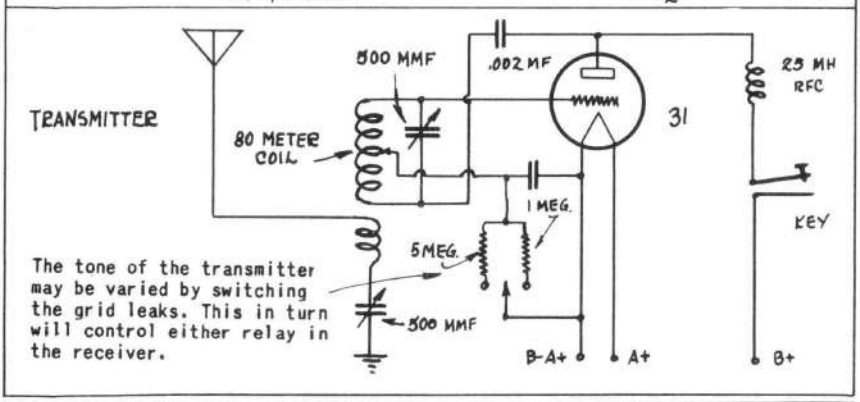


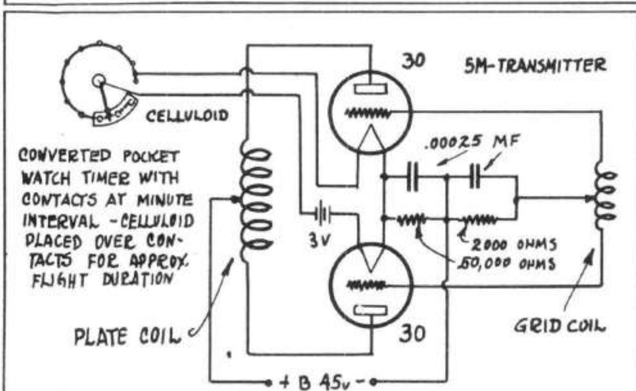
Two types of circuit have proven their worth on the 5 meter band, the superhet and the superregenerative receivers. The superhet rrquires many tubes and high plate voltage to obtain consistant results. The superregenerator may not equal the results obtained by the superhet but it is a lot easier to construct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

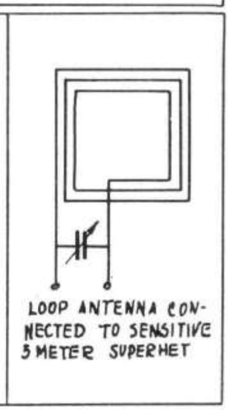
Trees, hill and fences decrease or cut off the signal to a great extent. The lower frequency seem to produce a more stable and dependable receiver.

The relays respond to different tones transmitted.

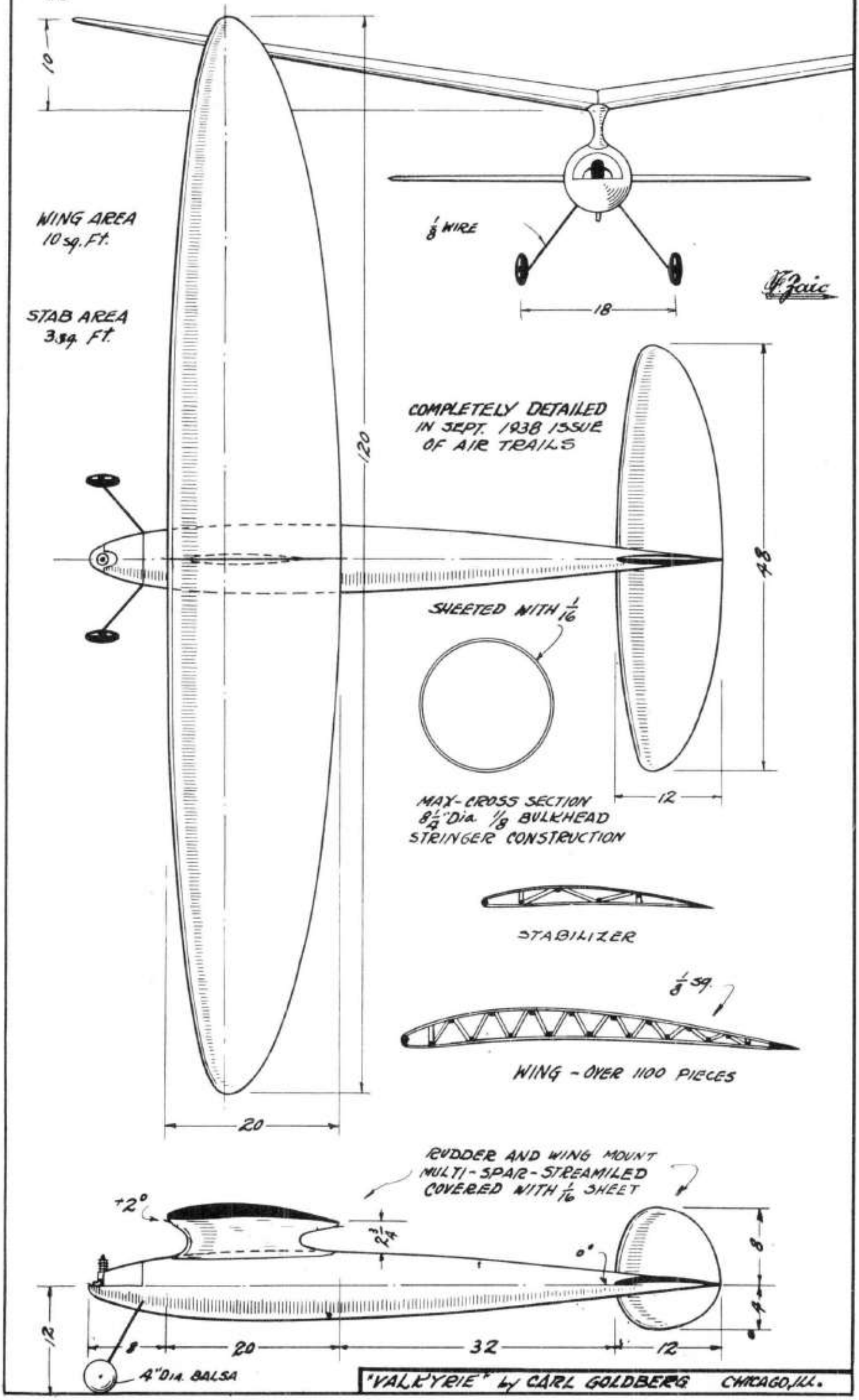


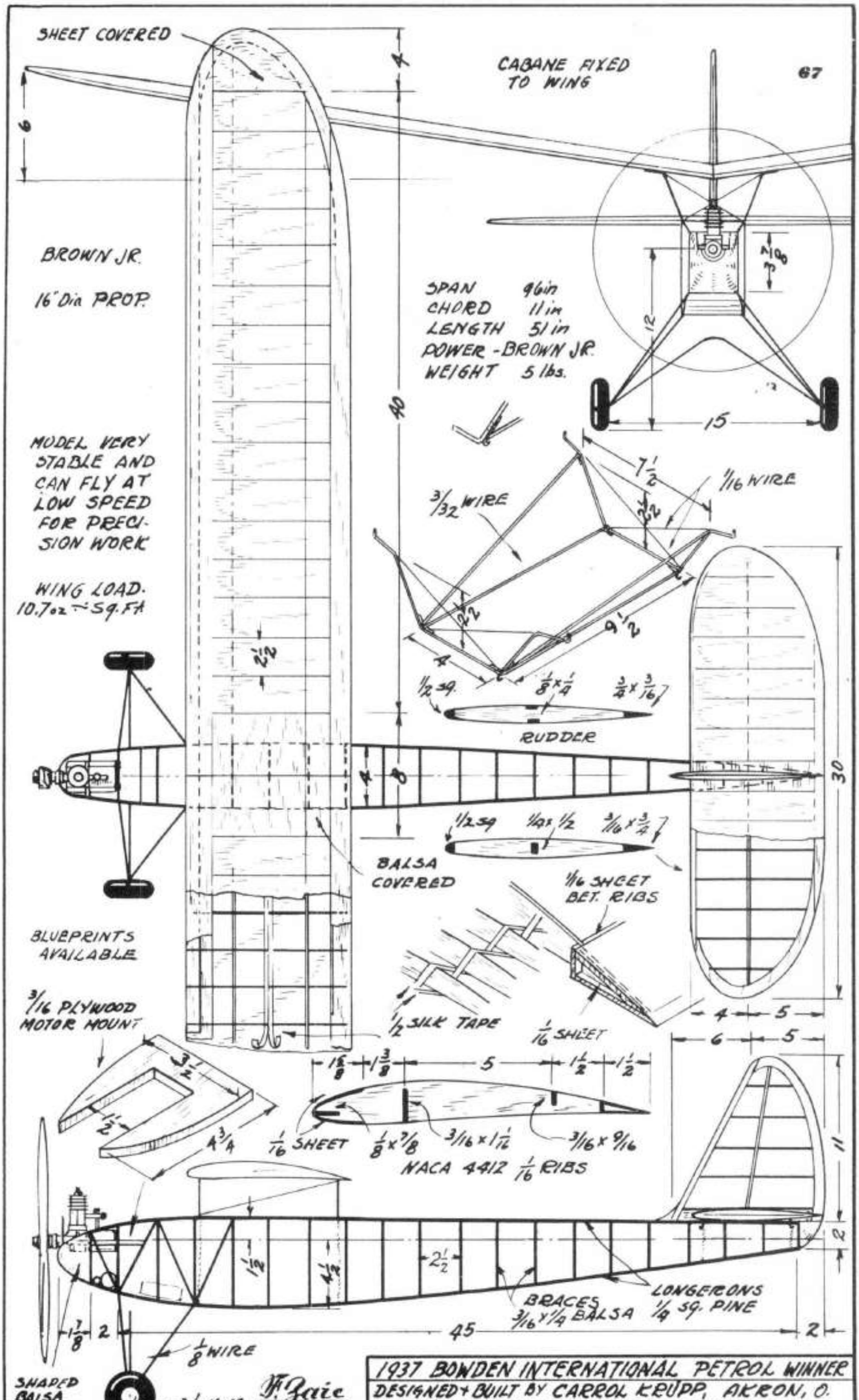


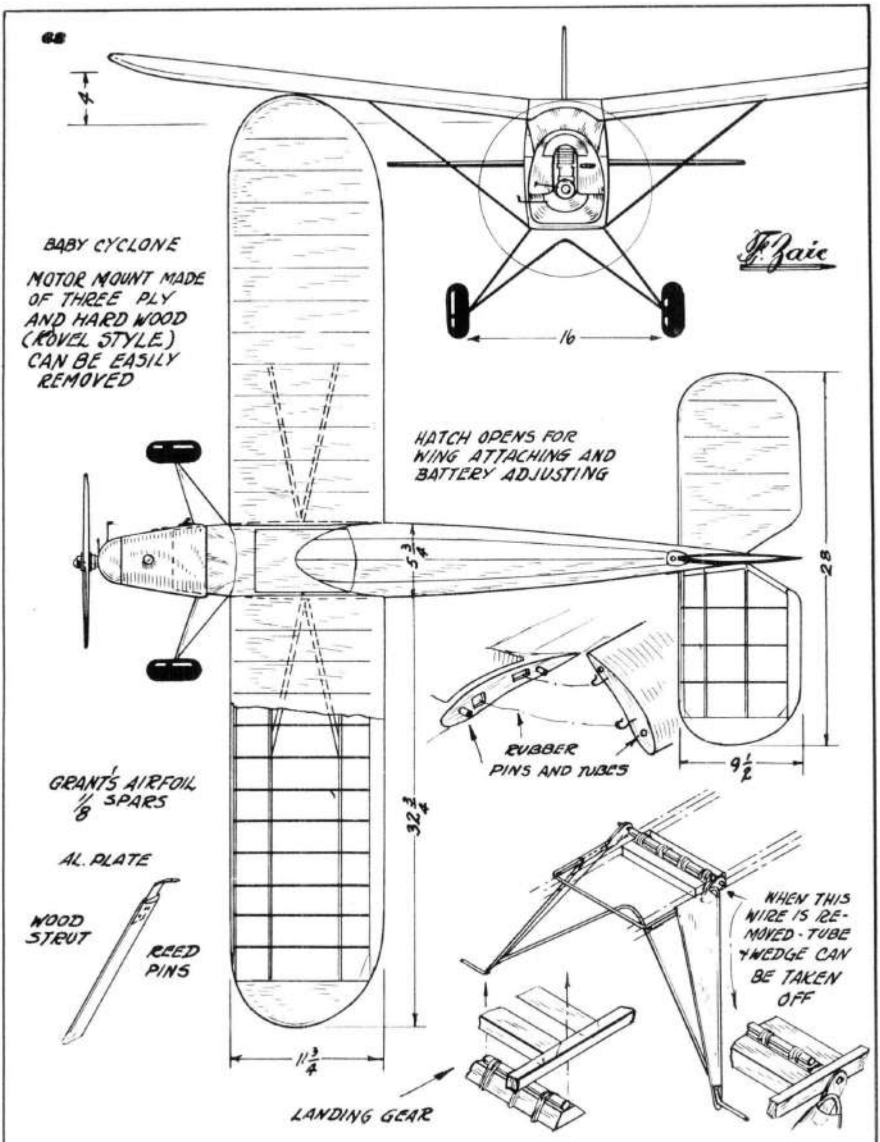




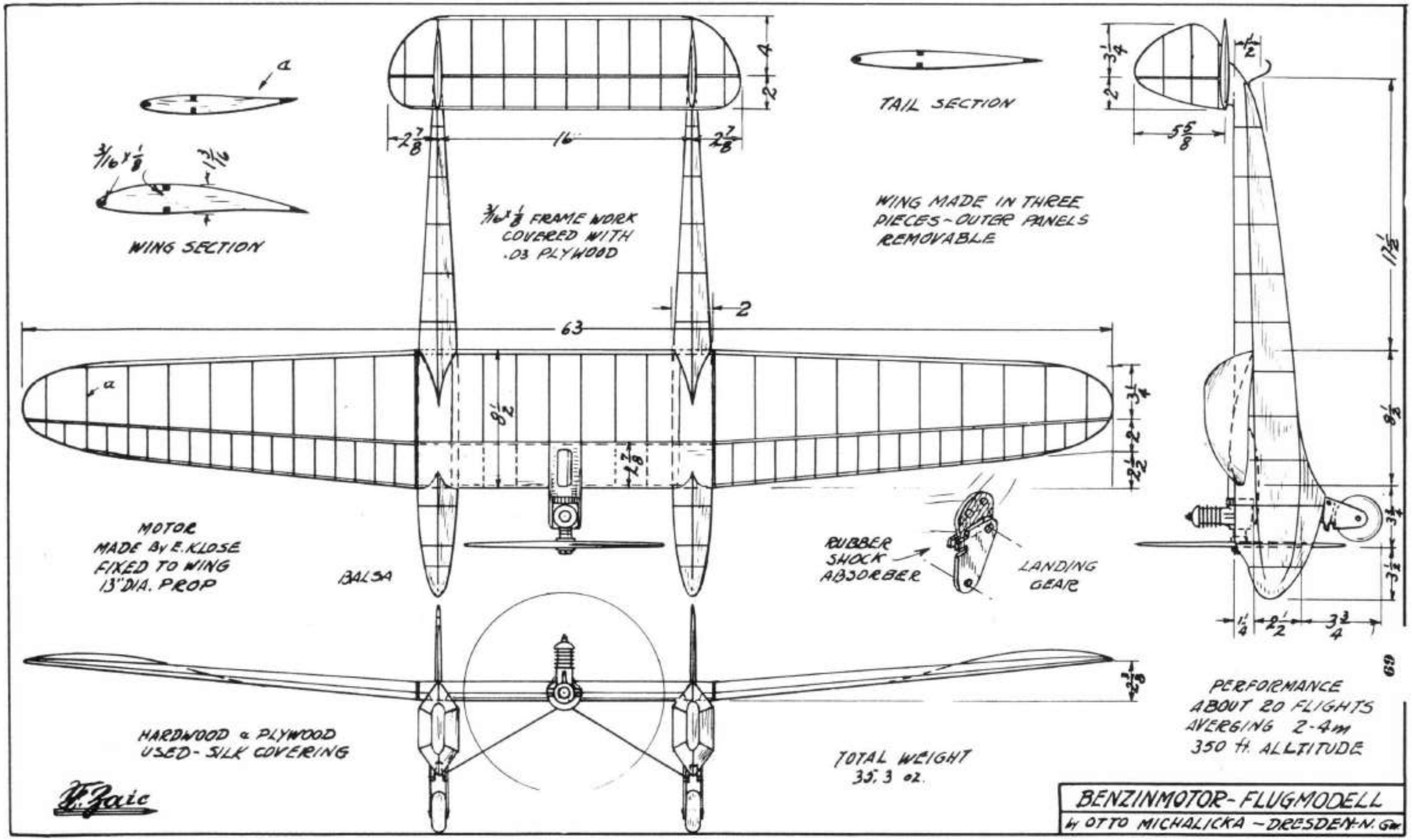
I am working on this device at the present time. The receiver is installed in a car. No more lost gas jobs with this idea. The transmitter can be built to weigh about 10 ounces and is installed in the plane. If after a length of time the model goes out of sight or is lost the transmitter signal is picked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


10
WING AREA 10 sq. Ft.
STAB AREA 3 sq. Ft.
1/8 WIRE
18
120
COMPLETELY DETAILED IN SEPT. 1938 ISSUE OF AIR TRAILS
48
SHEETED WITH 1/16
12
MAX-CROSS SECTION 8 1/4" Dia. 1/8 BULKHEAD STRINGER CONSTRUCTION
STABILIZER
1/8 sq.
WING - OVER 1100 PIECES
20
RUDDER AND WING MOUNT MULTI-SPAR-STREAMLINED COVERED WITH 1/16 SHEET
+2°
2 3/4
0°
8
4
12
8
20
32
12
4" DIA. BALSA
"VALKYRIE" by CARL GOLDBERG CHICAGO, ILL.

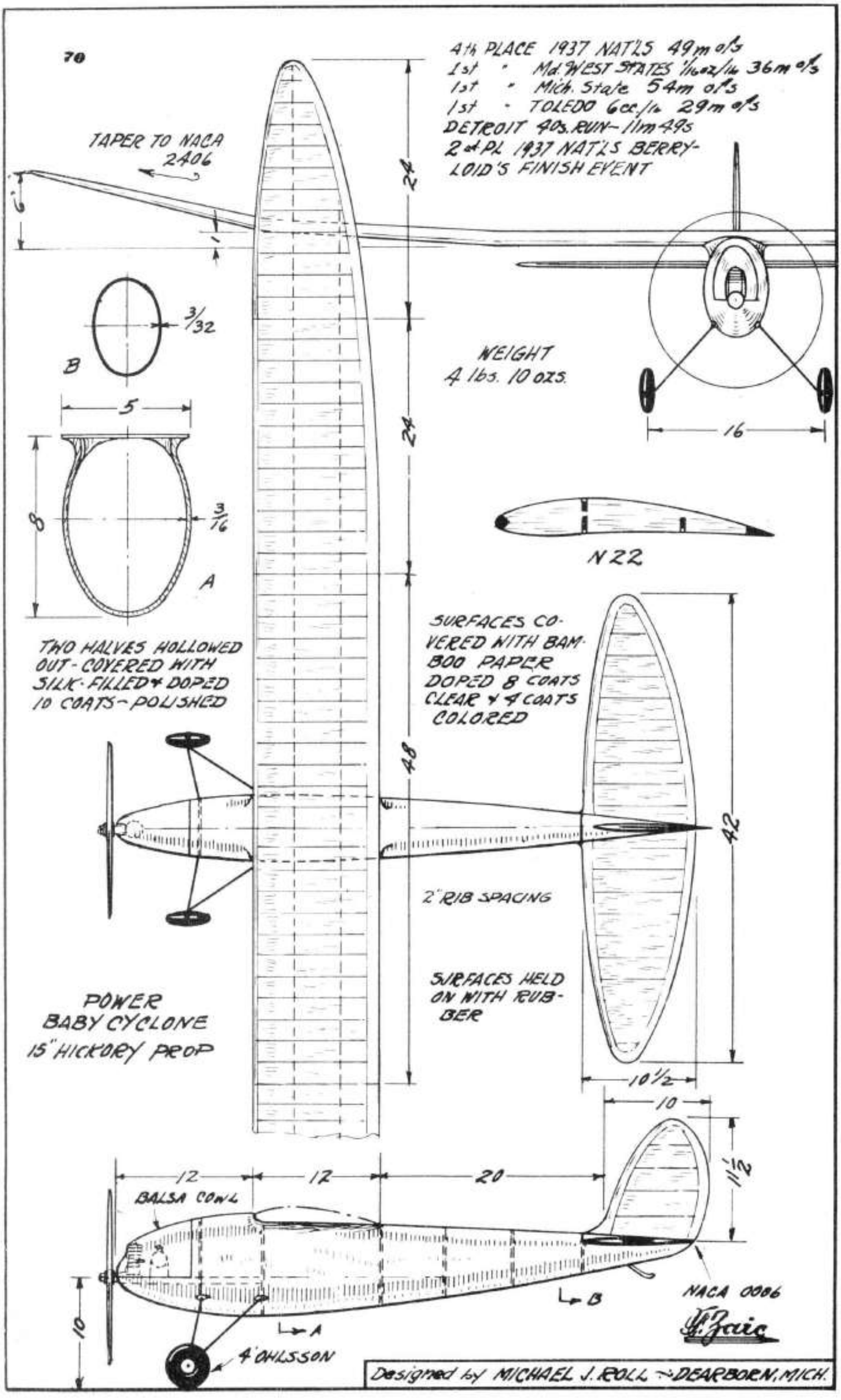

67
SHEET COVERED
CABANE FIXED TO WING
BROWN JR.
16" Dia PROP.
SPAN 96in
CHORD 11in
LENGTH 51in
POWER - BROWN JR.
WEIGHT 5 lbs.
MODEL VERY STABLE AND CAN FLY AT LOW SPEED FOR PRECISION WORK
WING LOAD. 10.7oz ÷ SQ.FT
3/32 WIRE
1/16 WIRE
1/2 SQ.
1/8 x 1/4
3/4 x 3/16
RUDDER
1/2 SQ
1/4 x 1/2
3/16 x 3/4
BALSA COVERED
1/16 SHEET BET. RIBS
BLUEPRINTS AVAILABLE
3/16 PLYWOOD MOTOR MOUNT
1/2 SILK TAPE
1/16 SHEET
1/16 SHEET
1/8 x 7/8
3/16 x 1 1/16
3/16 x 9/16
NACA 4412 1/16 RIBS
BRACES 3/16 x 1/4 BALSA
LONGERONS 1/4 SQ. PINE
1/8 WIRE
SHAPED BALSA BLOCKS
3 1/2 M+M
F. Zaic
1937 BOWDEN INTERNATIONAL PETROL WINNER
DESIGNED + BUILT BY CARROL KRUPP, AKRON, O.
FLOWN IN ENGLAND by HERBERT FISH, " "



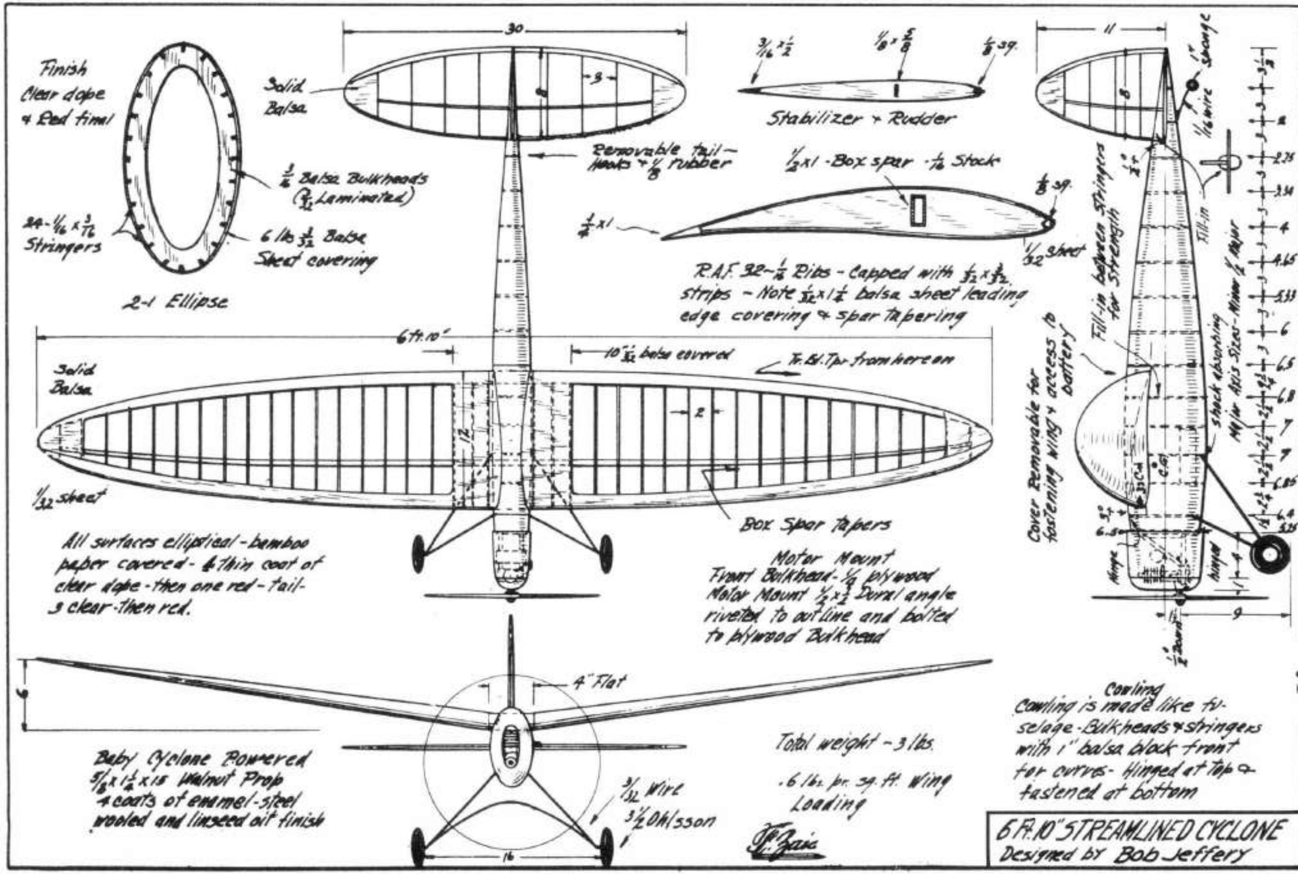
"CORSAIRE" by ALFRED VAN WYMERSCH - BRUSSELS, BELGIUM.

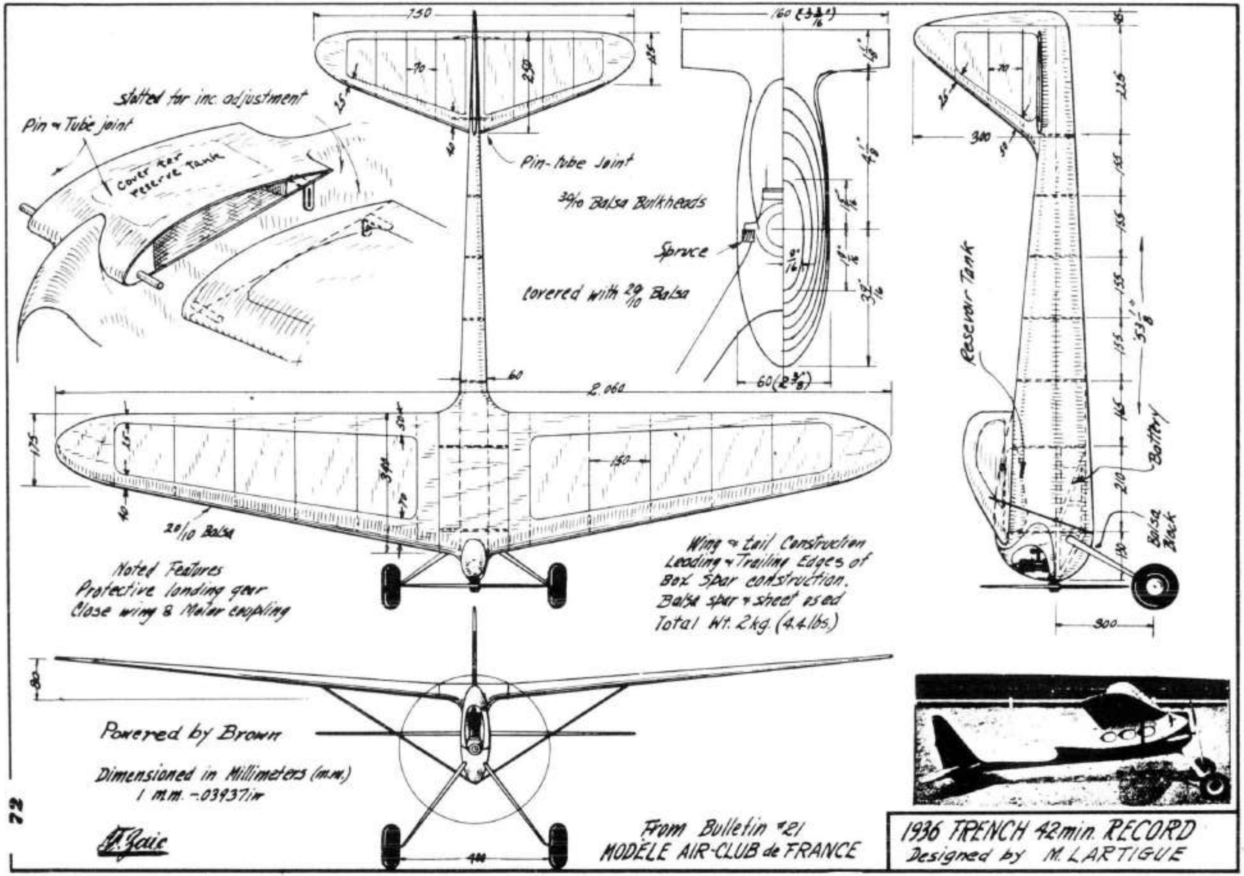


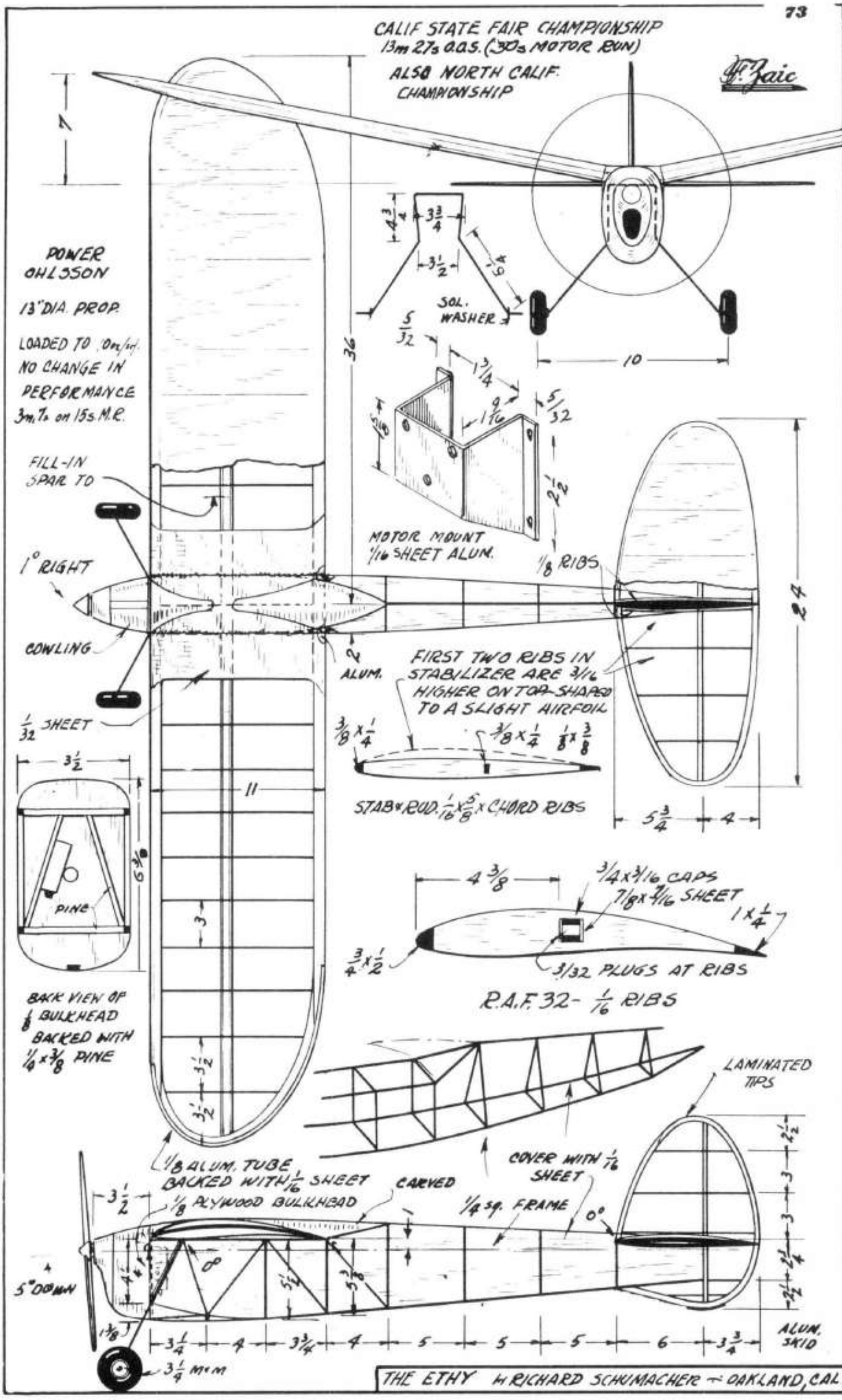
WING SECTION
3/16 x 1/8
3/16
a
3/16 x 1/8 FRAME WORK
COVERED WITH
.03 PLYWOOD
16
2 7/8
TAIL SECTION
WING MADE IN THREE
PIECES - OUTER PANELS
REMOVABLE
63
2
8 1/2
2 7/8
MOTOR
MADE BY E. KLOSE
FIXED TO WING
13" DIA. PROP
BALSA
RUBBER
SHOCK
ABSORBER
LANDING
GEAR
HARDWOOD & PLYWOOD
USED - SILK COVERING
TOTAL WEIGHT
35.3 oz.
PERFORMANCE
ABOUT 20 FLIGHTS
AVERGING 2-4m
350 ft. ALLTITUDE
BENZINMOTOR-FLUGMODELL
by OTTO MICHALICKA - DRESDEN-N. Gw.

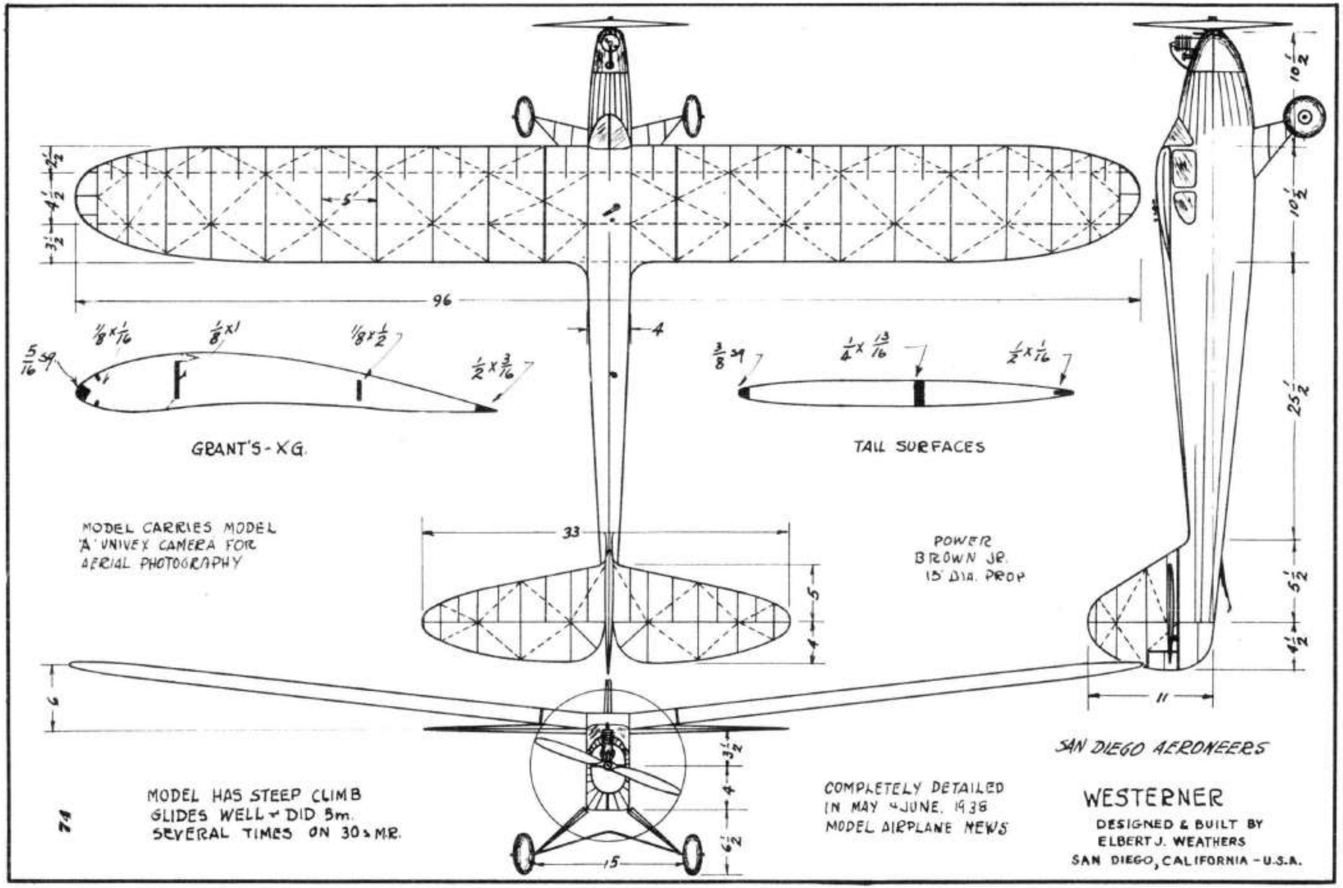


4th PLACE 1937 NAT'LS 49m o/s
1st " Md. WEST STATES 1/16oz/in 36m o/s
1st " Mich. State 54m o/s
1st " TOLEDO 6cc./in 29m o/s
DETROIT 40s. RUN—11m 49s
2nd PL 1937 NAT'LS BERRY-LOID'S FINISH EVENT
TAPER TO NACA 2406
6
1
24
24
48
3/32
B
5
8
3/16
A
WEIGHT 4 lbs. 10 ozs.
16
N22
TWO HALVES HOLLOWED OUT - COVERED WITH SILK - FILLED & DOPED 10 COATS - POLISHED
SURFACES COVERED WITH BAMBOO PAPER DOPED 8 COATS CLEAR & 4 COATS COLORED
42
2" RIB SPACING
SURFACES HELD ON WITH RUBBER
POWER BABY CYCLONE 15" HICKORY PROP
10½
10
11½
12
12
20
BALSA COWL
10
A
B
NACA 0006
4" OHLSSON
Designed by MICHAEL J. ROLL — DEARBORN, MICH.

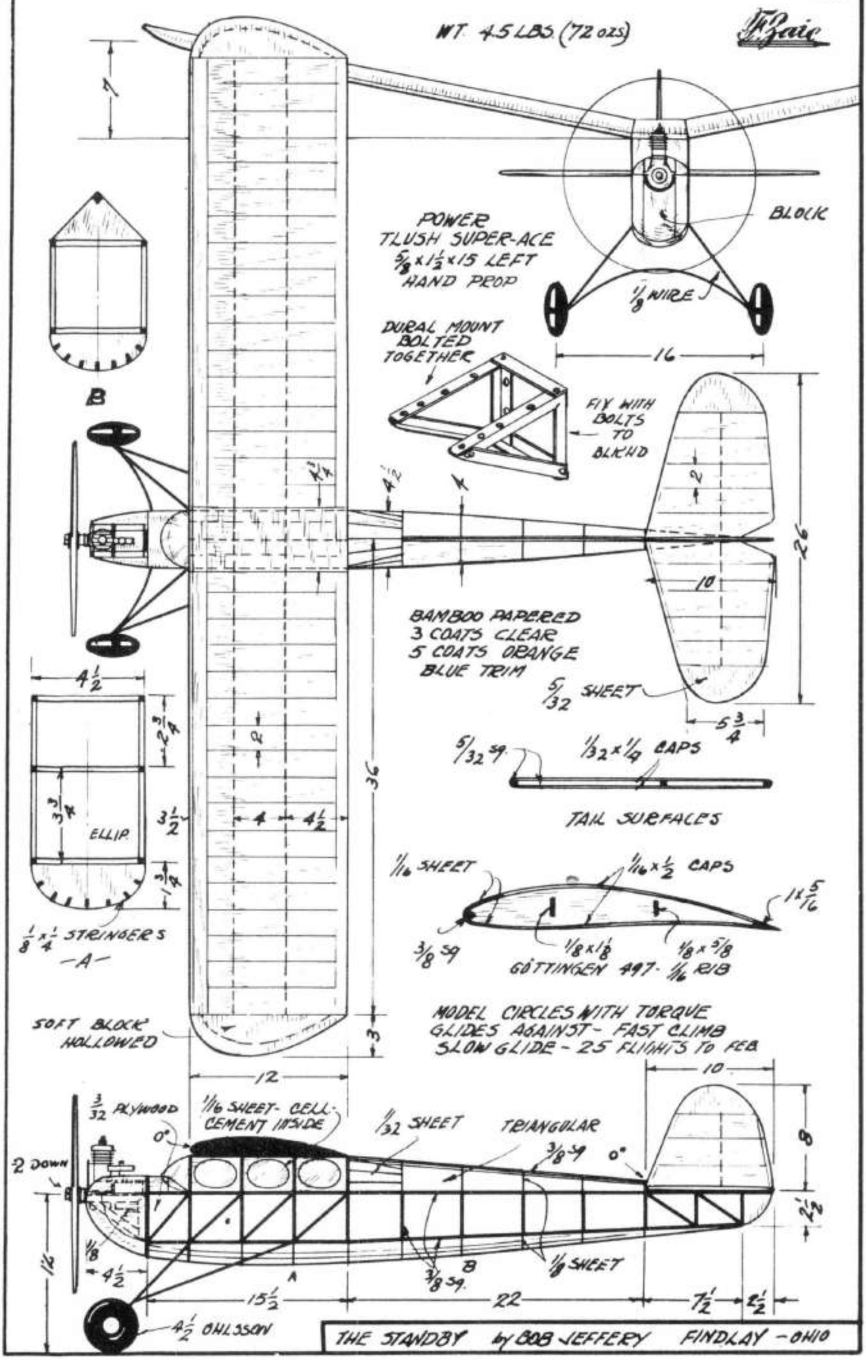

Finish
Clear dope
& Red trim
24-1/16 x 3/16
Stringers
3/16 Balsa Bulkheads
(1/32 Laminated)
6 lb 3/32 Balsa
Sheet covering
2-1 Ellipse
Solid
Balsa
30
Removable tail-
hooks & 1/8 rubber
Stabilizer & Rudder
1/2 x 1 - Box spar - 1/16 Stock
1/4 x 1
1/32 sheet
R.A.F. 32 - 1/8 Ribs - Capped with 1/32 x 3/32
strips - Note 1/32 x 1 1/4 balsa sheet leading
edge covering & spar tapering
6 ft. 10"
10" 1/32 balsa covered
Tr. Ed. Tpr. from here on
1/32 sheet
Box Spar Tapers
All surfaces elliptical - bamboo
paper covered - & thin coat of
clear dope - then one red - tail -
3 clear - then red.
Motor Mount
Front Bulkhead - 1/4 plywood
Motor Mount 1/2 x 1/2 Dural angle
riveted to outline and bolted
to plywood Bulkhead
Fill-in between Stringers
for strength
Cover Removable for
fastening wing & access to
battery
Shock absorbing
Major Axis Sizes - Minor 1/2 Major
1" sponge
1/16 wire
Fill-in
Hinge
hinged
4" Flat
Baby Cyclone Powered
5/8 x 1 1/4 x 15 Walnut Prop
4 coats of enamel - steel
wooled and linseed oil finish
3/32 Wire
3 1/2 Ohlsson
16
Total weight - 3 lbs.
.6 lbs. pr. sq. ft. Wing
Loading
Cowling
Cowling is made like fu-
selage - Bulkheads & stringers
with 1" balsa block front
for curves - Hinged at top &
fastened at bottom
6 Ft. 10" STREAMLINED CYCLONE
Designed by Bob Jeffery


Slotted for inc. adjustment
Pin & Tube joint
Cover for reserve tank
Pin-tube Joint
30/10 Balsa Bulkheads
Spruce
Covered with 20/10 Balsa
Reservoir Tank
Battery
Balsa Block
20/10 Balsa
Noted Features
Protective landing gear
Close wing & Motor coupling
Wing & tail Construction
Leading & Trailing Edges of
Box Spar construction.
Balsa spar & sheet used
Total Wt. 2kg. (4.4 lbs.)
Powered by Brown
Dimensioned in Millimeters (m.m.)
1 mm. = .03937 in
From Bulletin #21
MODÈLE AIR-CLUB de FRANCE
1936 FRENCH 42min. RECORD
Designed by M. LARTIGUE

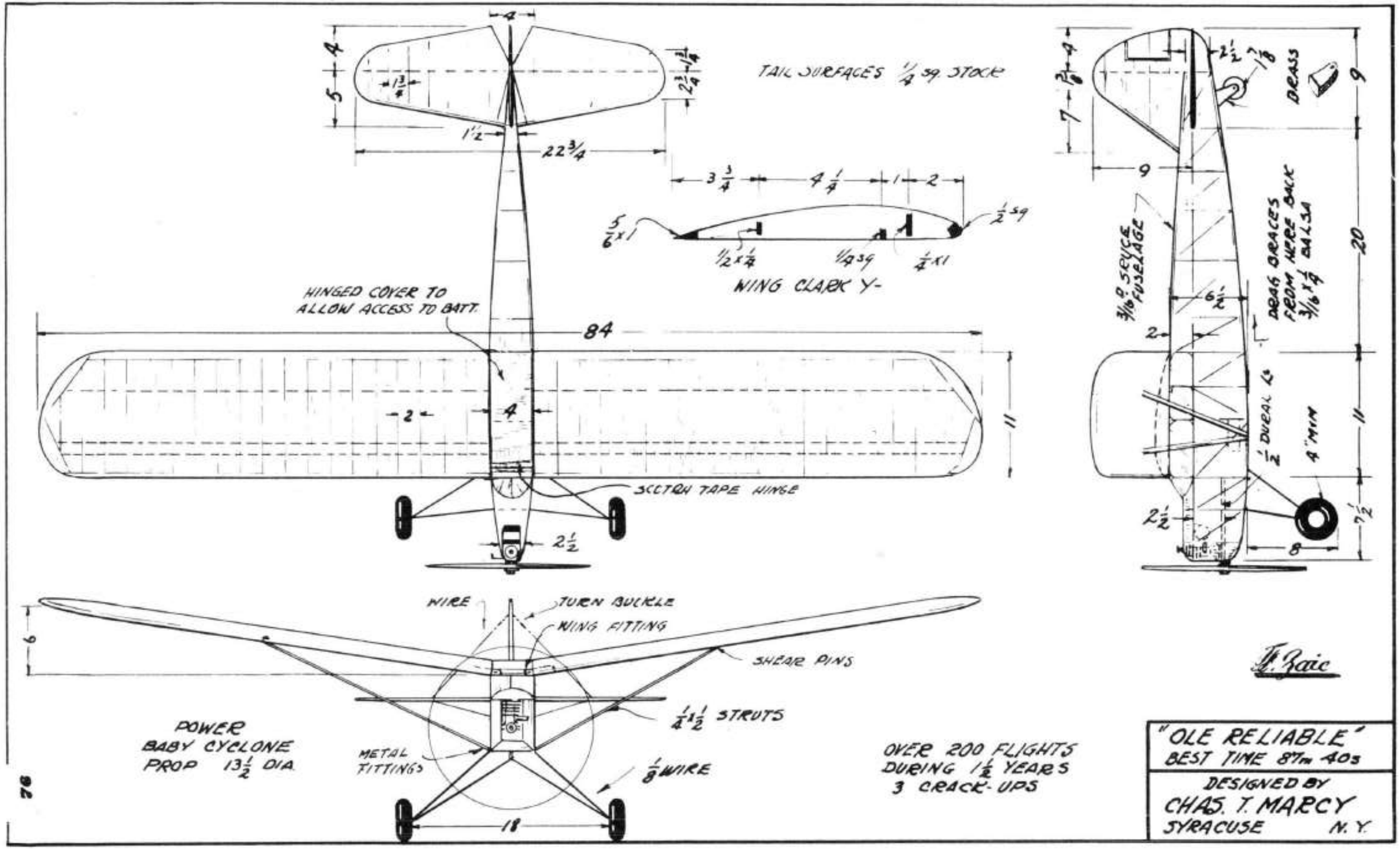

CALIF STATE FAIR CHAMPIONSHIP
13m 27s O.O.S. (30s MOTOR RUN)
ALSO NORTH CALIF. CHAMPIONSHIP
W. Zaic
POWER OHLSSON
13" DIA. PROP.
NO CHANGE IN PERFORMANCE
3m 7s on 15s M.R.
FILL-IN SPAR TO
1° RIGHT
COWLING
1/32 SHEET
SOL. WASHER
MOTOR MOUNT 1/16 SHEET ALUM.
1/8 RIBS
2 ALUM.
FIRST TWO RIBS IN STABILIZER ARE 3/16 HIGHER ON TOP-SHAPED TO A SLIGHT AIRFOIL
STAB & RUD. 1/16 x 5/8 x CHORD RIBS
PINE
BACK VIEW OF 1/8 BULKHEAD BACKED WITH 1/4 x 3/8 PINE
3/4 x 3/16 CAPS
7/8 x 3/16 SHEET
3/32 PLUGS AT RIBS
R.A.F. 32 - 1/16 RIBS
LAMINATED TIPS
1/8 ALUM. TUBE BACKED WITH 1/16 SHEET
1/8 PLYWOOD BULKHEAD
CARVED
COVER WITH 1/16 SHEET
1/4 sq. FRAME
5° DOWN
3 1/4 M&M
ALUM. SKID
THE ETHY H. RICHARD SCHUMACHER - OAKLAND, CAL.

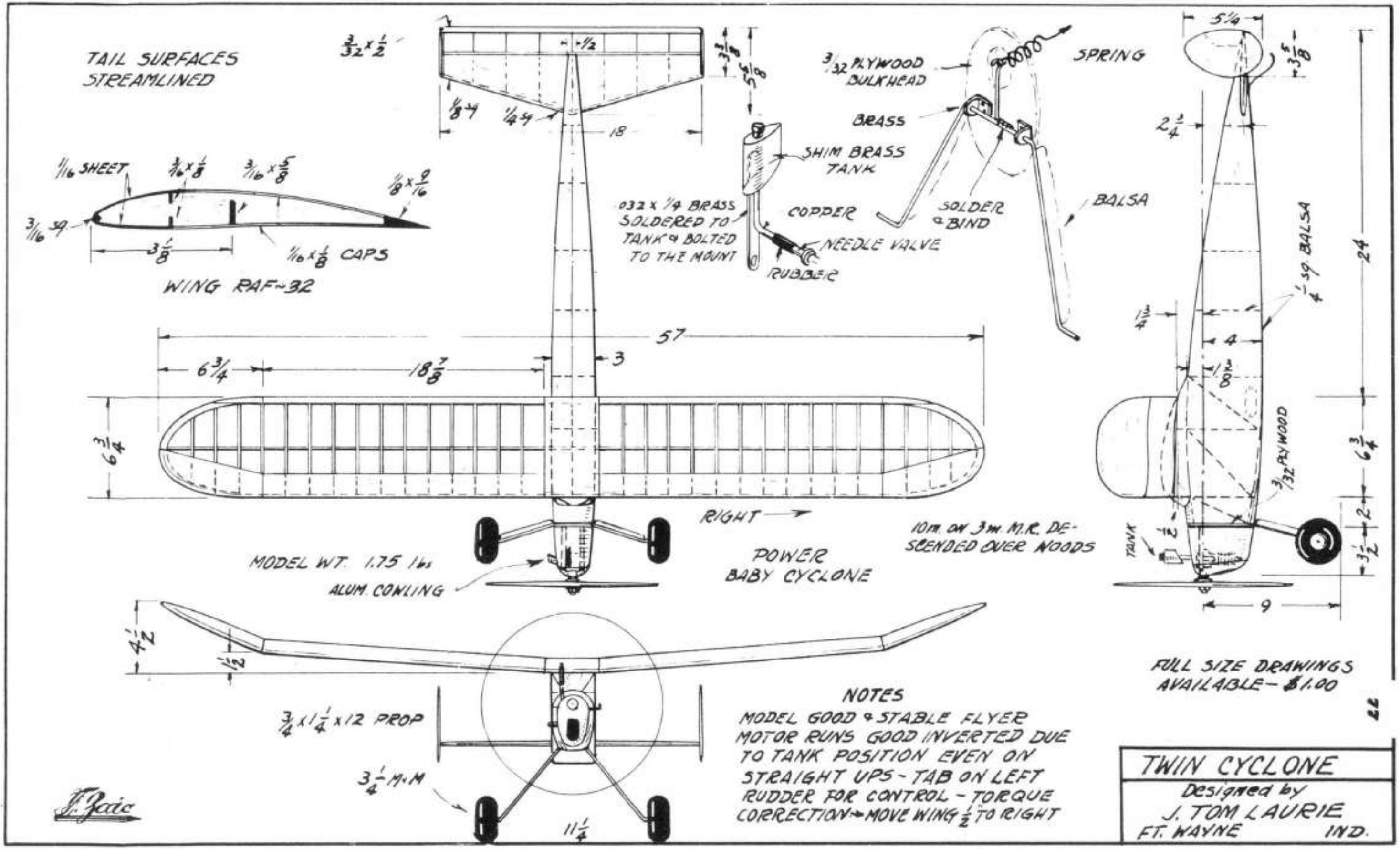


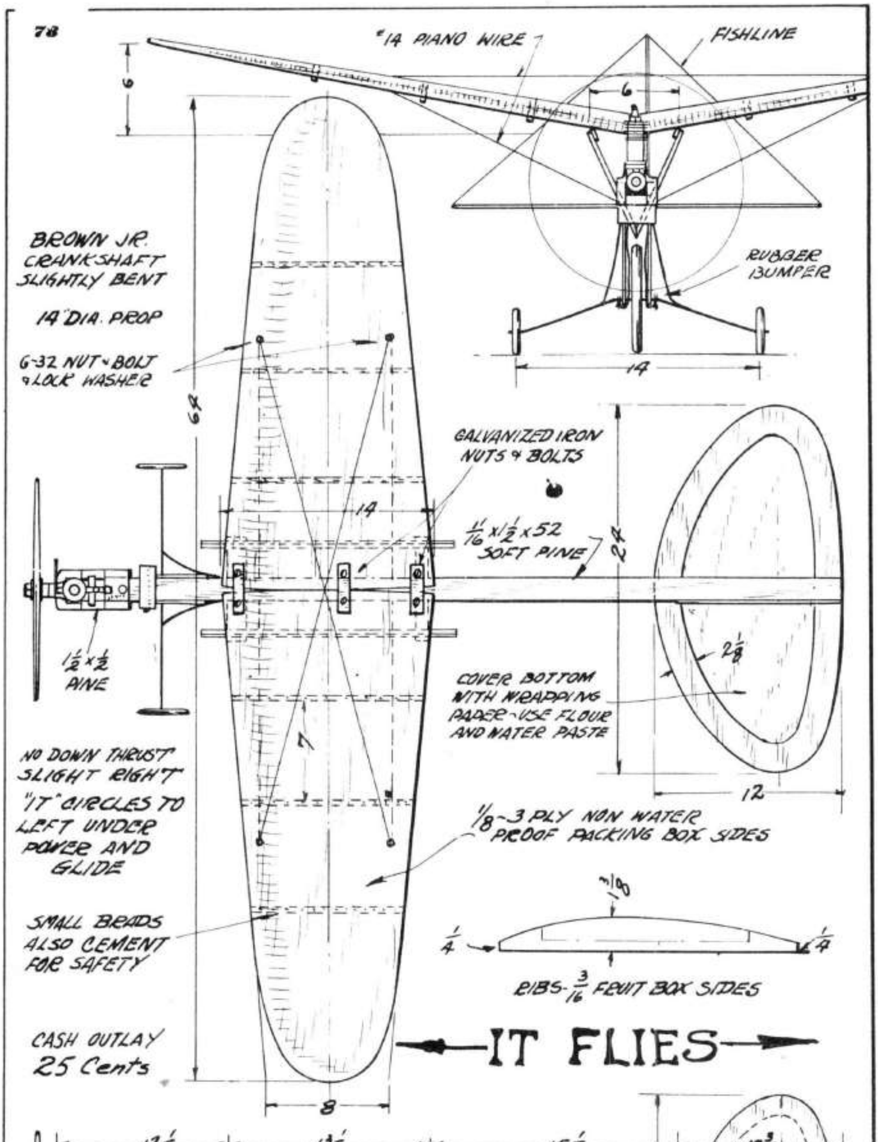
96
4
GRANT'S-XG.
TAIL SURFACES
33
MODEL CARRIES MODEL 'A' UNIVEX CAMERA FOR AERIAL PHOTOGRAPHY
POWER BROWN JR. 15" DIA. PROP
11
15
SAN DIEGO AERONEERS
MODEL HAS STEEP CLIMB GLIDES WELL & DID 5m. SEVERAL TIMES ON 30s M.R.
COMPLETELY DETAILED IN MAY & JUNE, 1938 MODEL AIRPLANE NEWS
WESTERNER
DESIGNED & BUILT BY ELBERT J. WEATHERS SAN DIEGO, CALIFORNIA - U.S.A.

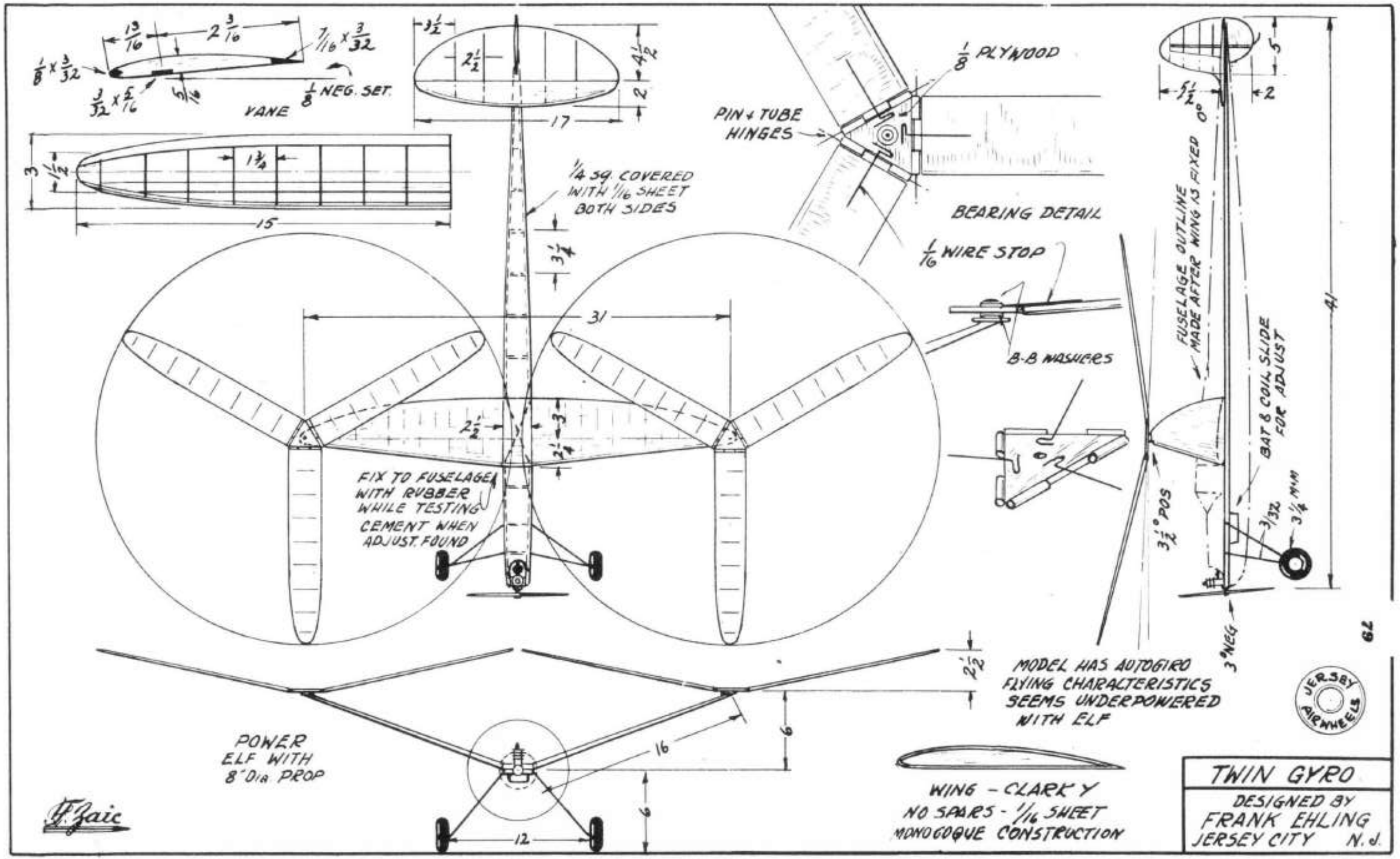


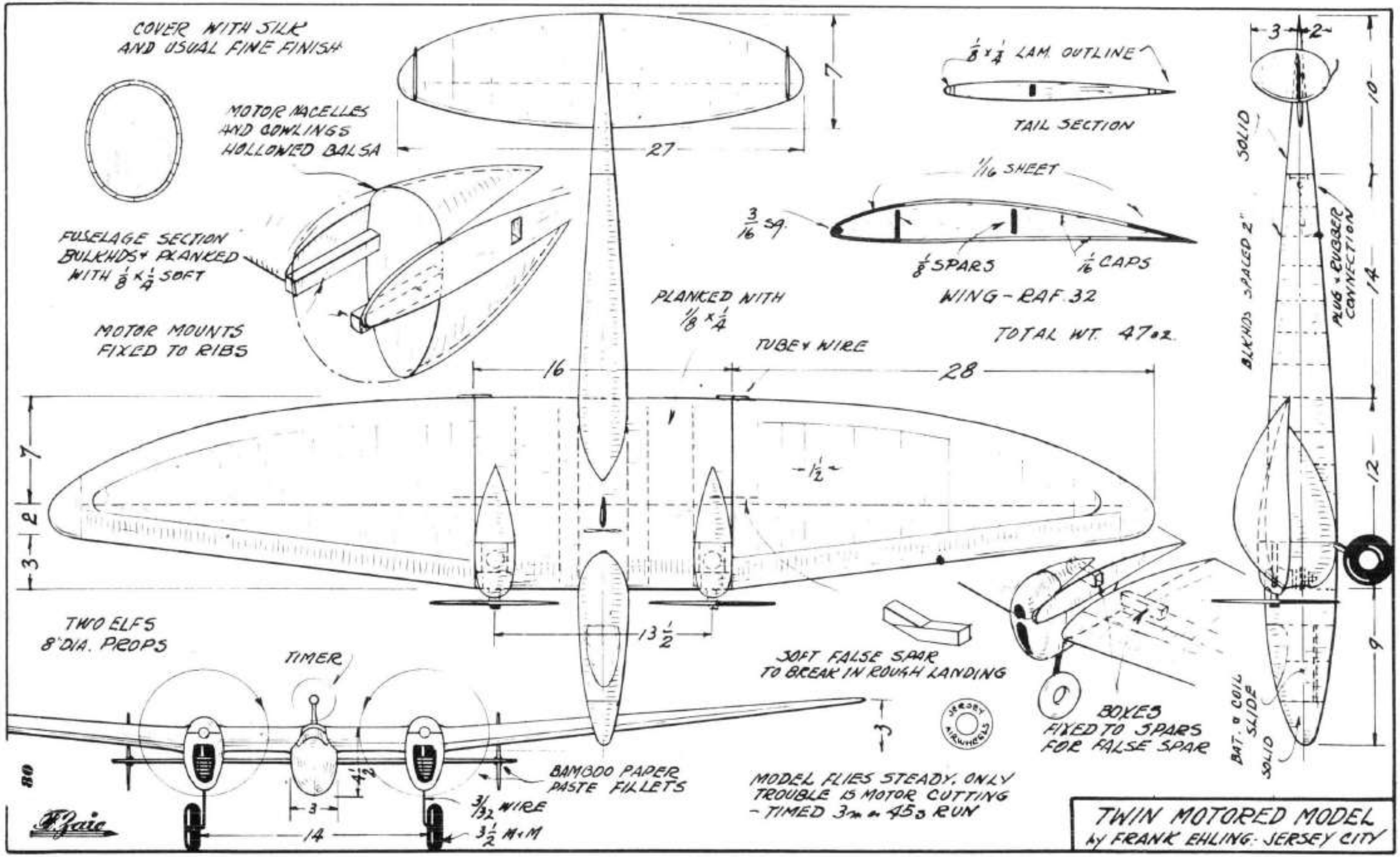
WT. 4.5 LBS. (72 OZS)
F. Zaic
POWER
TLUSH SUPER-ACE
5/8 x 1 1/2 x 15 LEFT
HAND PROP
BLOCK
1/8 WIRE
16
DURAL MOUNT
BOLTED
TOGETHER
FIX WITH
BOLTS
TO
BLKHD
B
BAMBOO PAPERED
3 COATS CLEAR
5 COATS ORANGE
BLUE TRIM
5/32 SHEET
26
10
5 3/4
5/32 SQ
1/32 x 1/4 CAPS
TAIL SURFACES
4 1/2
2 3/4
3 3/4
ELLIP.
3 1/2
1 3/4
1/8 x 1/4 STRINGERS
-A-
36
4
4 1/2
1/16 SHEET
1/16 x 1/2 CAPS
1 x 5/16
3/8 SQ
1/8 x 1 1/8
1/8 x 5/8
GÖTTINGEN 497 - 1/16 RIB
MODEL CIRCLES WITH TORQUE
GLIDES AGAINST - FAST CLIMB
SLOW GLIDE - 25 FLIGHTS TO FEB.
SOFT BLOCK
HOLLOWED
3
12
3/32 PLYWOOD
1/16 SHEET - CELL. CEMENT INSIDE
1/32 SHEET
TRIANGULAR
3/8 SQ
0°
2 DOWN
8
2 1/2
1/8
4 1/2
12
1/8 SHEET
3/8 SQ.
15 1/2
22
7 1/2
2 1/2
4 1/2 OHLSSON
THE STANDBY by BOB JEFFERY FINDLAY - OHIO


76
TAIL SURFACES 1/4 SQ. STOCK
WING CLARK Y-
HINGED COVER TO ALLOW ACCESS TO BATT.
SCOTCH TAPE HINGE
84
3/16 SQ. SPRUCE FUSELAGE
DRAG BRACES FROM HERE BACK 3/16 x 1/4 BALSA
1/2 DURAL L's
4" MIN
BRASS
WIRE
TURN BUCKLE
WING FITTING
SHEAR PINS
1/4 x 1/2 STRUTS
METAL FITTINGS
1/8 WIRE
POWER
BABY CYCLONE
PROP 13 1/2 DIA
OVER 200 FLIGHTS
DURING 1 1/2 YEARS
3 CRACK-UPS
"OLE RELIABLE"
BEST TIME 8m 40s
DESIGNED BY
CHAS. T. MARCY
SYRACUSE N.Y.

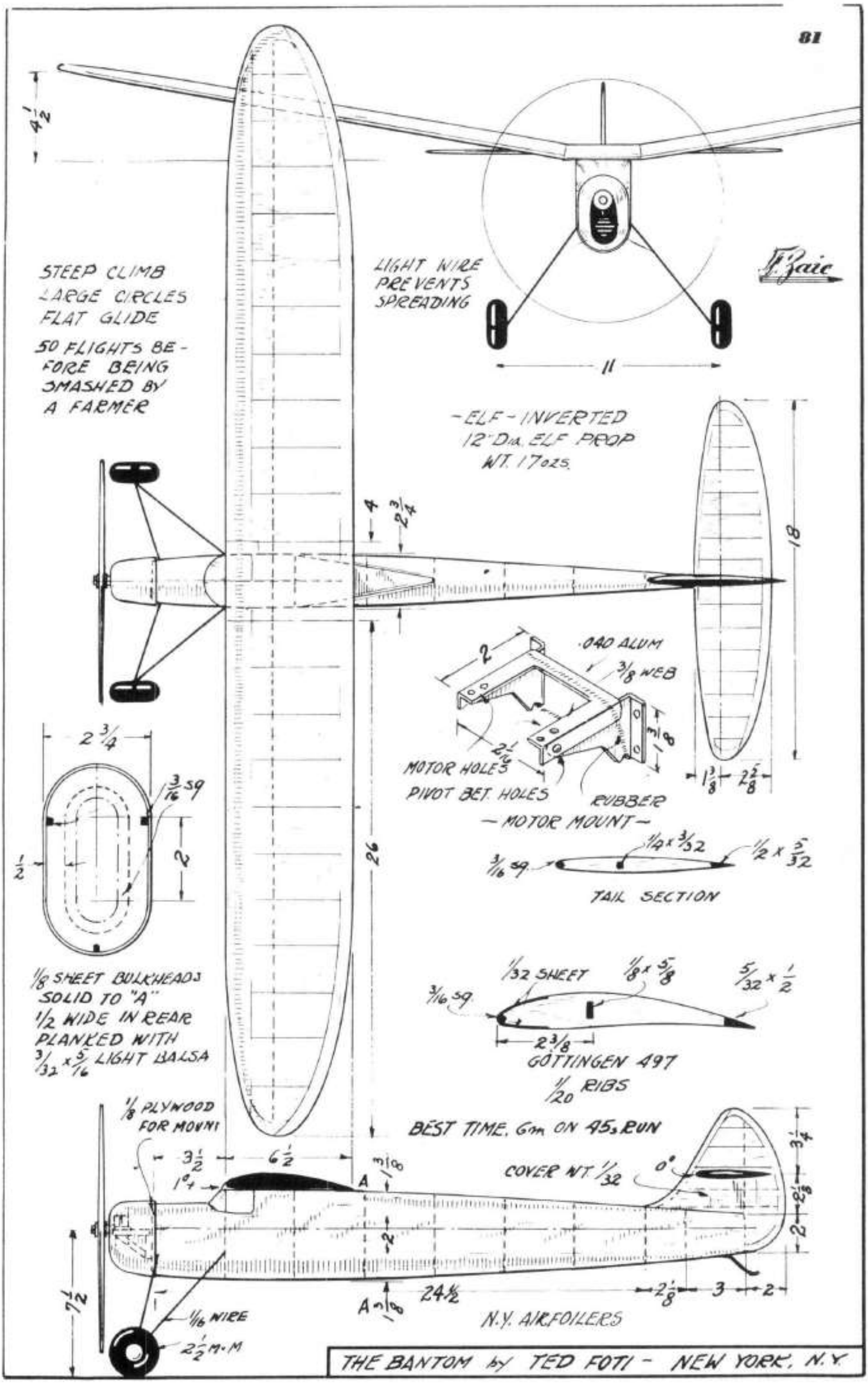

TAIL SURFACES STREAMLINED
3/32 x 1/2
1/8 sq
1/4 sq
18
3/32 PLYWOOD BULKHEAD
SPRING
BRASS
SHIM BRASS TANK
.032 x 1/4 BRASS SOLDERED TO TANK & BOLTED TO THE MOUNT
COPPER
NEEDLE VALVE
RUBBER
SOLDER & BIND
BALSA
1/16 SHEET
3/16 x 1/8
3/16 x 5/8
1/8 x 9/16
3/16 sq
1/16 x 1/8 CAPS
WING RAF-32
57
6 3/4
18 7/8
3
RIGHT
10 m. on 3 m. M.R. DESCENDED OVER WOODS
MODEL WT. 1.75 lbs
ALUM. COWLING
POWER BABY CYCLONE
1/4 sq. BALSA
3/32 PLYWOOD
24
TANK
9
3/4 x 1 1/4 x 12 PROP
3 1/4 M.M
11 1/4
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.
22

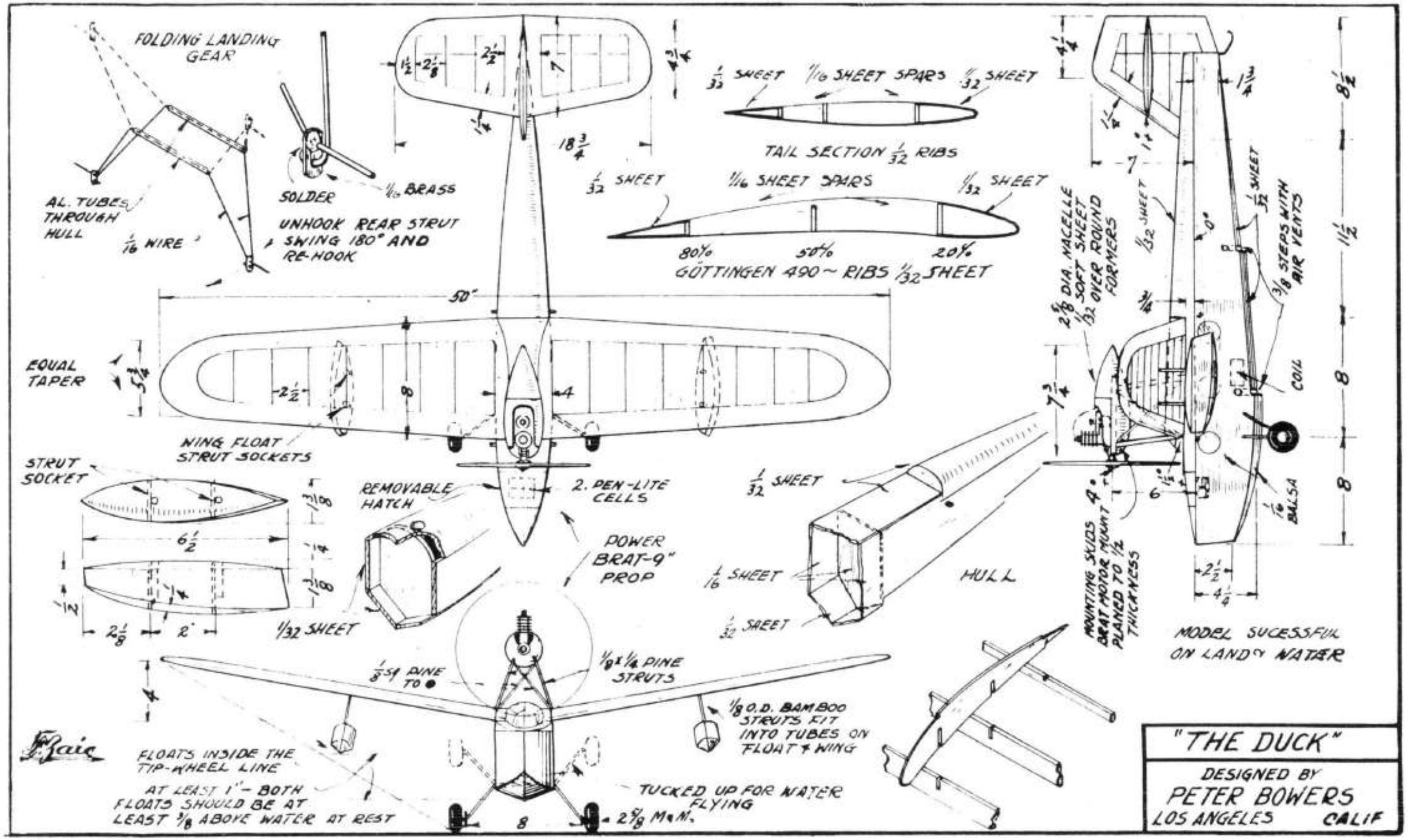

#14 PIANO WIRE
FISHLINE
6
6
RUBBER BUMPER
14
BROWN JR. CRANKSHAFT SLIGHTLY BENT
14" DIA. PROP
6-32 NUT & BOLT & LOCK WASHER
62
GALVANIZED IRON NUTS & BOLTS
14
1/16 x 1/2 x 52 SOFT PINE
24
1 1/2 x 1/2 PINE
2 1/8
COVER BOTTOM WITH WRAPPING PAPER - USE FLOUR AND WATER PASTE
NO DOWN THRUST SLIGHT RIGHT
"IT" CIRCLES TO LEFT UNDER POWER AND GLIDE
7
12
1/8 - 3 PLY NON WATER PROOF PACKING BOX SIDES
3/16
1/4
1/4
SMALL BRADS ALSO CEMENT FOR SAFETY
RIBS - 3/16 FRUIT BOX SIDES
CASH OUTLAY 25 Cents
IT FLIES
8
12 1/2
13 1/2
15 1/4
10 3/4
11
1/4
4 1/16
3/8 - 3 PLY PINE
3 3/16
NAILS
RUBB
NAILS
1/8 PLYWOOD NAIL TO FUSELAGE
.010 ALUM. NAILED ON
BATTERY BOX
1/4 WOOD SCREWS
7" DOLL BUGGY
3" WOOD
F. Zaic
THE STREAMLINED BARN DOOR
by HENRY STIGLMEIER - INGLEWOOD CALIF.

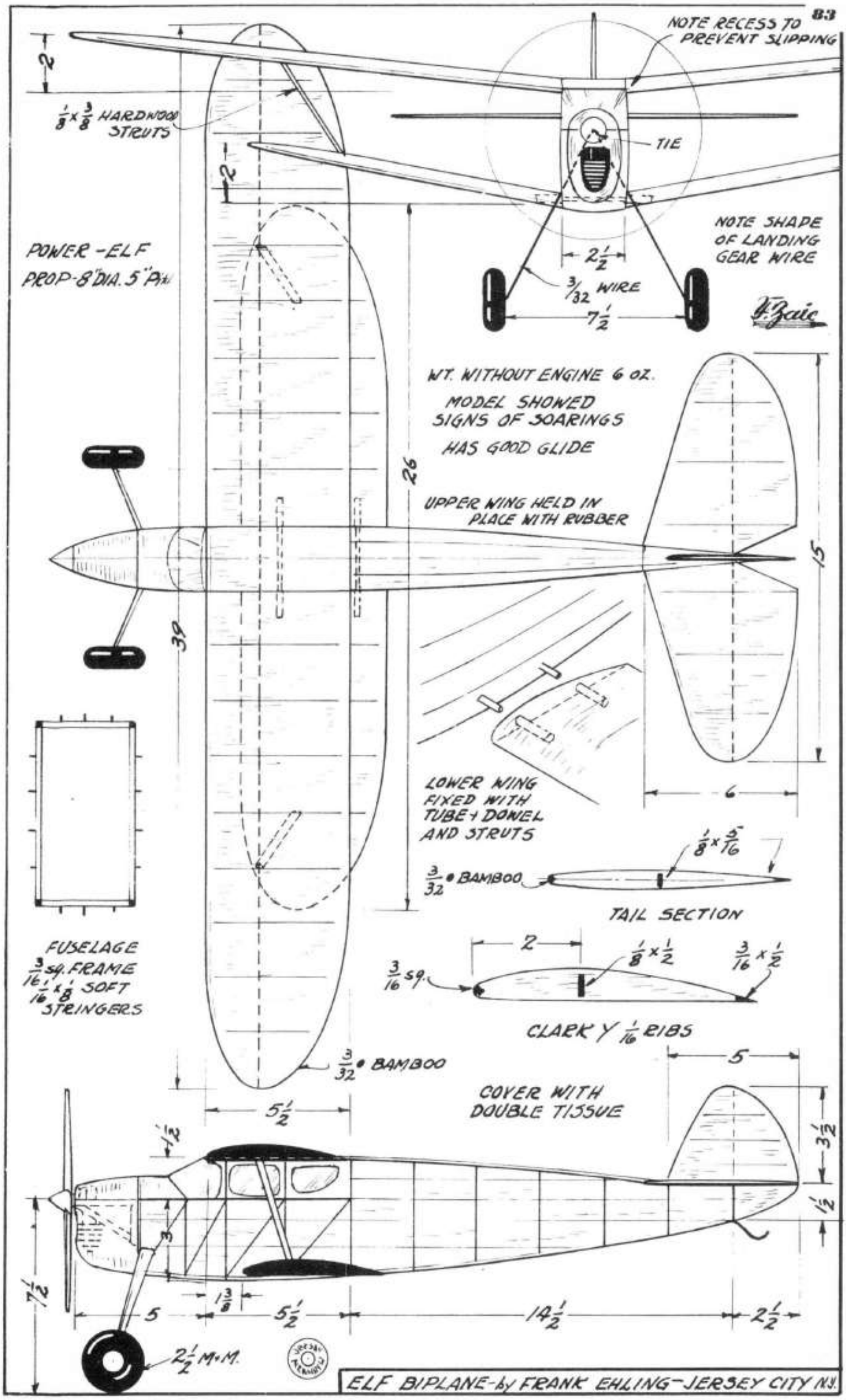

TWIN GYRO
DESIGNED BY
FRANK EHLING
JERSEY CITY N.J.
JERSBY AIRWHEELS
MODEL HAS AUTOGIRO
FLYING CHARACTERISTICS
SEEMS UNDERPOWERED
WITH ELF
WING - CLARK Y
NO SPARS - 1/16 SHEET
MONOCOQUE CONSTRUCTION
POWER
ELF WITH
8" DIA. PROP
FIX TO FUSELAGE
WITH RUBBER
WHILE TESTING
CEMENT WHEN
ADJUST. FOUND
1/4 SQ. COVERED
WITH 1/16 SHEET
BOTH SIDES
VANE
1/8 NEG. SET.
1/8 PLYWOOD
PIN & TUBE
HINGES
BEARING DETAIL
1/16 WIRE STOP
B-B WASHERS
FUSELAGE OUTLINE
MADE AFTER WING IS FIXED
BAT & COIL SLIDE
FOR ADJUST
3 1/2° POS
3° NEG
3 1/4 M.M
3/32
41
31
17
15
16
12
F. Zaic

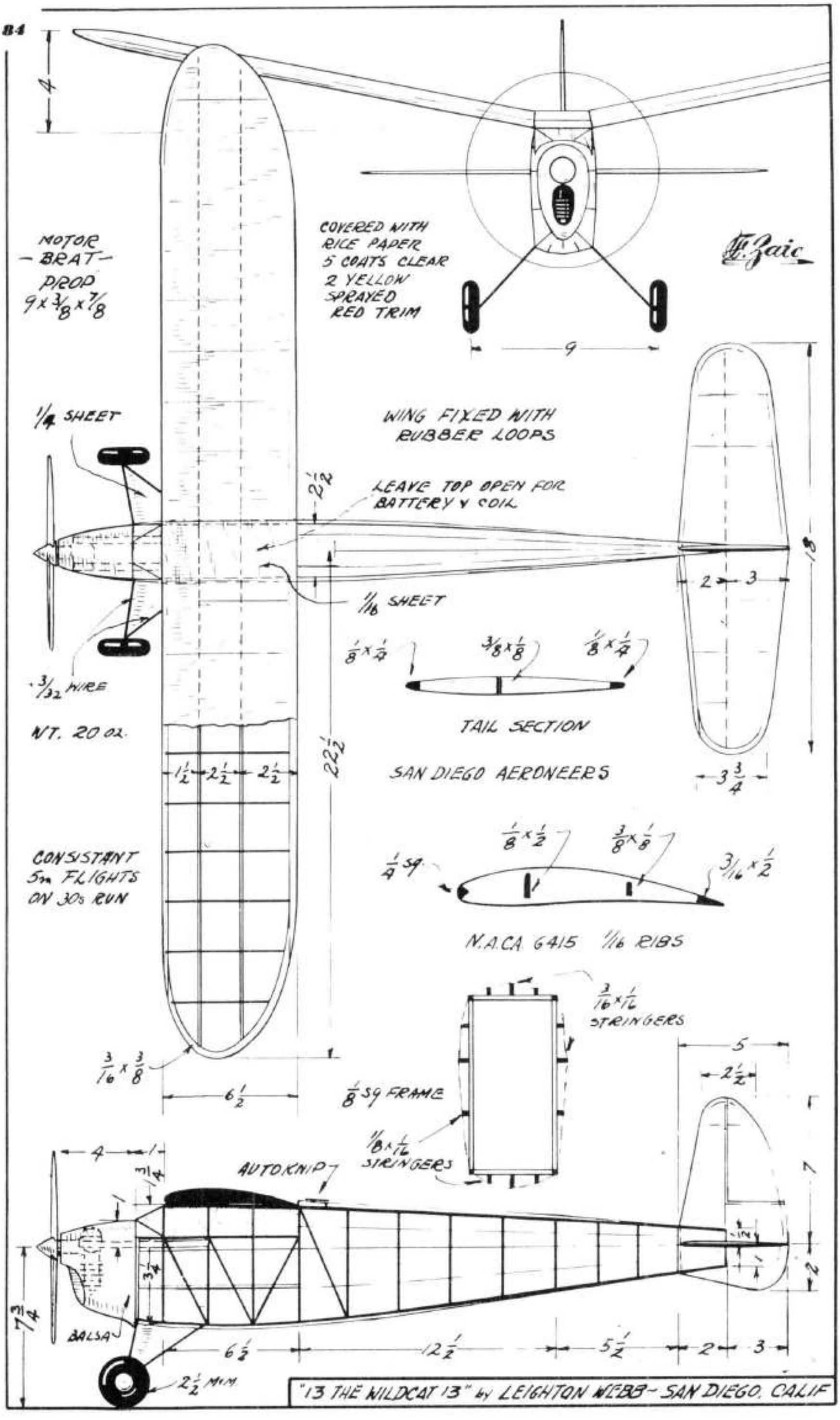


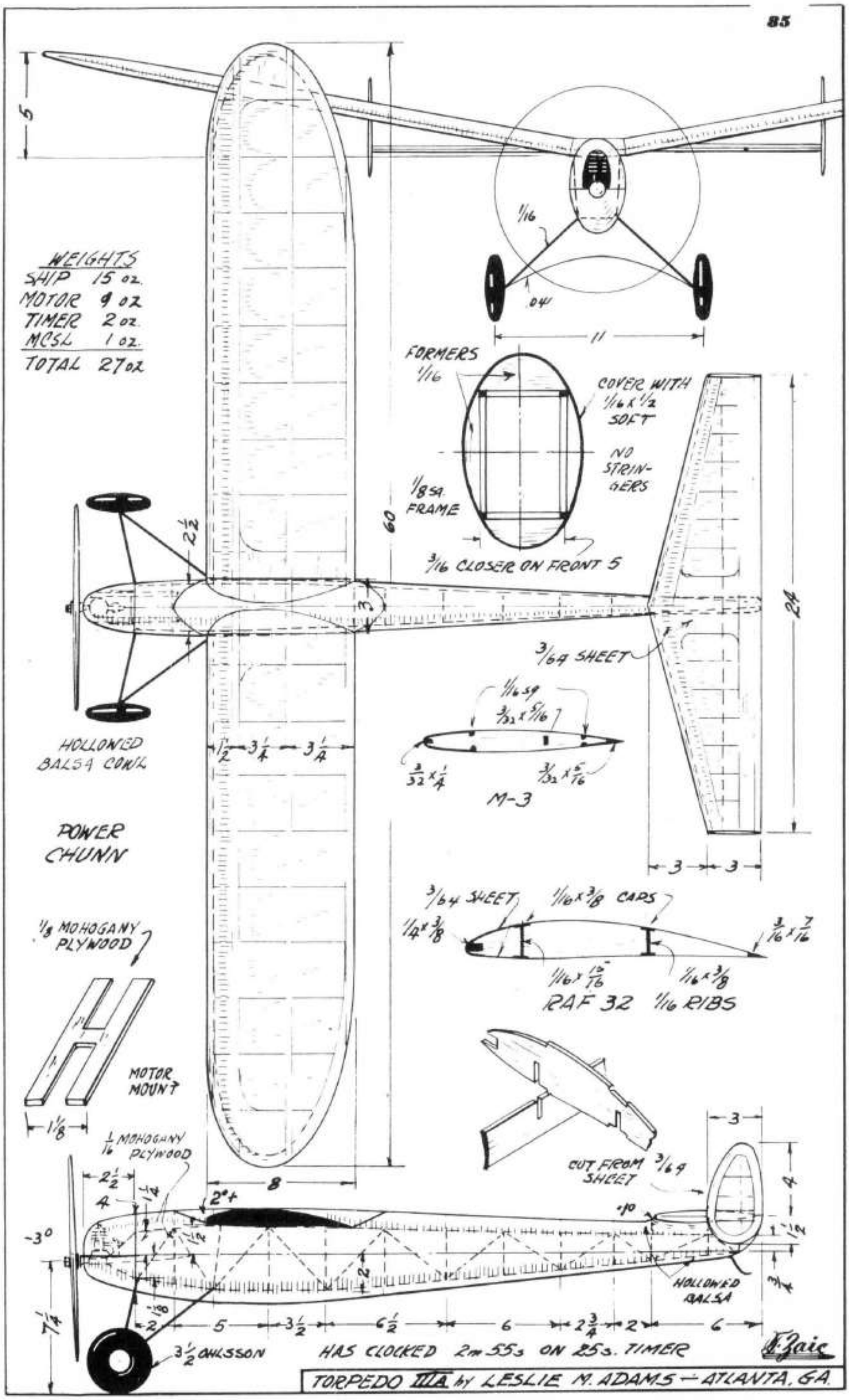
COVER WITH SILK AND USUAL FINE FINISH
MOTOR NACELLES AND COWLINGS HOLLOWED BALSA
FUSELAGE SECTION BULKHDS & PLANKED WITH 1/8 × 1/4 SOFT
MOTOR MOUNTS FIXED TO RIBS
27
7
1/8 × 1/4 LAM. OUTLINE
TAIL SECTION
1/16 SHEET
3/16 SQ.
1/8 SPARS
1/16 CAPS
WING - RAF 32
PLANKED WITH 1/8 × 1/4
TOTAL WT. 47 oz.
TUBE & WIRE
16
28
1 1/2
7
2
3
TWO ELFS 8" DIA. PROPS
13 1/2
TIMER
SOFT FALSE SPAR TO BREAK IN ROUGH LANDING
JERSEY AIRWHEELS
BOXES FIXED TO SPARS FOR FALSE SPAR
BAMBOO PAPER PASTE FILLETS
3/32 WIRE
3 1/2 M & M
4 1/2
3
14
MODEL FLIES STEADY. ONLY TROUBLE IS MOTOR CUTTING - TIMED 3m or 45s RUN
SOLID
BLKHDS SPACED 2"
PLUG & RUBBER CONNECTION
BAT. & COIL SLIDE
SOLID
10
14
12
9
80
TWIN MOTORED MODEL
by FRANK EHLING - JERSEY CITY

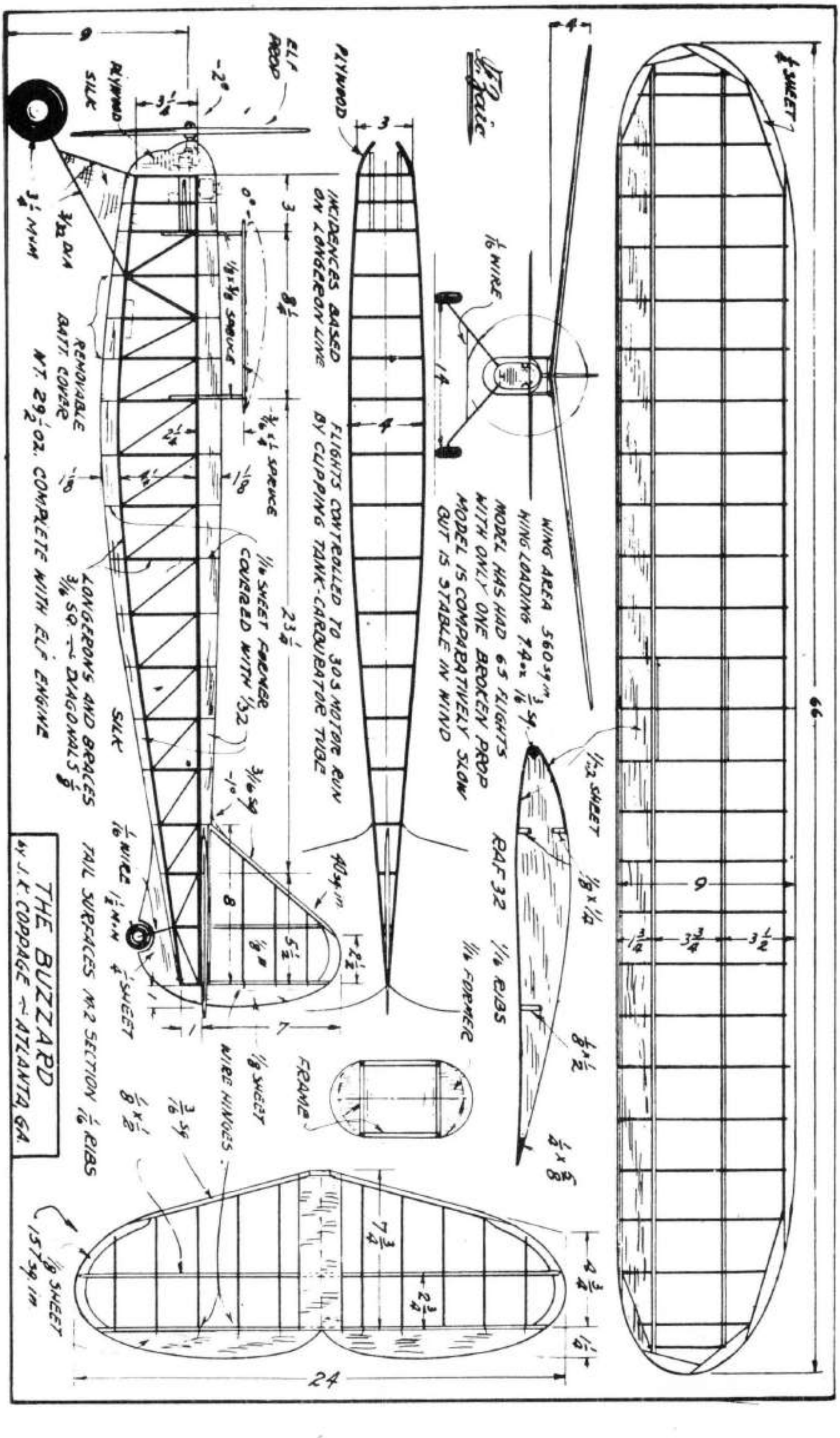

STEEP CLIMB
LARGE CIRCLES
FLAT GLIDE
50 FLIGHTS BEFORE BEING SMASHED BY A FARMER
LIGHT WIRE PREVENTS SPREADING
-ELF- INVERTED
12" DIA. ELF PROP
WT. 17 OZS.
.040 ALUM
3/8 WEB
MOTOR HOLES
PIVOT BET. HOLES
RUBBER
- MOTOR MOUNT -
1/4 x 3/32
1/2 x 5/32
3/16 sq.
TAIL SECTION
1/8 SHEET BULKHEADS SOLID TO "A"
1/2 WIDE IN REAR
PLANKED WITH 3/32 x 5/16 LIGHT BALSA
3/16 sq.
1/32 SHEET
1/8 x 5/8
5/32 x 1/2
GOTTINGEN 497
1/20 RIBS
1/8 PLYWOOD FOR MOUNT
BEST TIME, 6m ON 45s RUN
COVER WT. 1/32
1/16 WIRE
2 1/2 M.M
N.Y. AIRFOILERS
THE BANTOM by TED FOTI - NEW YORK, N.Y.

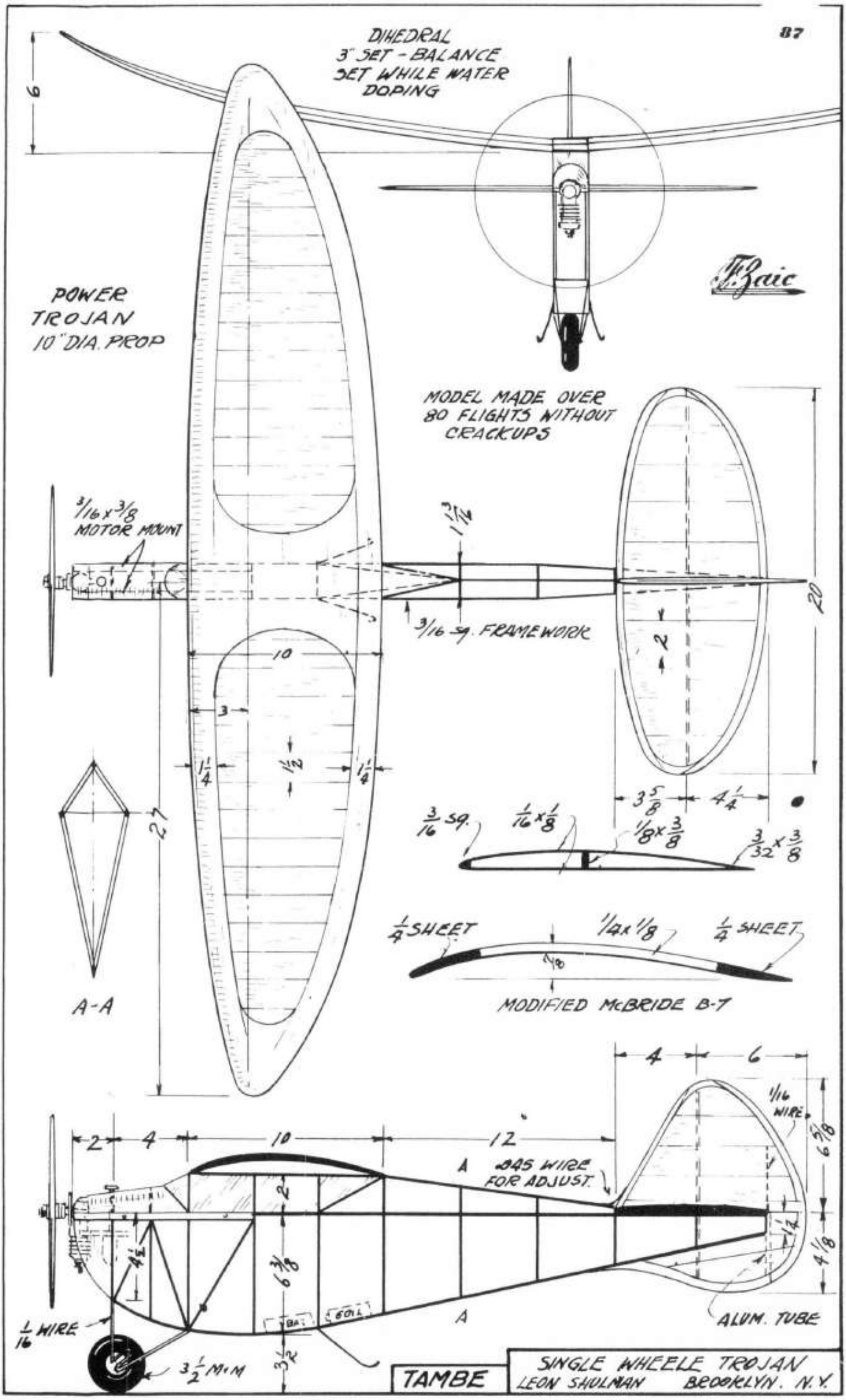

FOLDING LANDING GEAR
AL. TUBES THROUGH HULL
1/16 WIRE
SOLDER
1/16 BRASS
UNHOOK REAR STRUT SWING 180° AND RE-HOOK
18 3/4
1/32 SHEET
1/16 SHEET SPARS
1/32 SHEET
TAIL SECTION 1/32 RIBS
80%
50%
20%
GÖTTINGEN 490 ~ RIBS 1/32 SHEET
50"
EQUAL TAPER
WING FLOAT STRUT SOCKETS
STRUT SOCKET
REMOVABLE HATCH
2. PEN-LITE CELLS
POWER BRAT-9" PROP
1/32 SHEET
1/16 SHEET
HULL
2 5/8 DIA. NACELLE 1/32 SOFT SHEET OVER ROUND FORMERS
1/32 SHEET
3/8 STEPS WITH AIR VENTS
COIL
1/16 BALSA
MOUNTING SKIDS BRAT MOTOR MOUNT PLANED TO 1/2 THICKNESS
MODEL SUCESSFUL ON LAND & WATER
1/8 SQ PINE TO ●
1/8 x 1/4 PINE STRUTS
1/8 O.D. BAMBOO STRUTS FIT INTO TUBES ON FLOAT & WING
FLOATS INSIDE THE TIP-WHEEL LINE
AT LEAST 1" - BOTH FLOATS SHOULD BE AT LEAST 3/8 ABOVE WATER AT REST
TUCKED UP FOR WATER FLYING
2 5/8 M & M.
"THE DUCK"
DESIGNED BY
PETER BOWERS
LOS ANGELES CALIF


NOTE RECESS TO PREVENT SLIPPING
1/8 x 3/8 HARDWOOD STRUTS
TIE
NOTE SHAPE OF LANDING GEAR WIRE
POWER-ELF
PROP-8" DIA. 5" PI.
2 1/2
3/32 WIRE
7 1/2
WT. WITHOUT ENGINE 6 OZ.
MODEL SHOWED SIGNS OF SOARINGS
HAS GOOD GLIDE
UPPER WING HELD IN PLACE WITH RUBBER
26
39
15
LOWER WING FIXED WITH TUBE + DOWEL AND STRUTS
6
1/8 x 5/16
3/32 BAMBOO
TAIL SECTION
FUSELAGE 3/16 SQ. FRAME 1/16 x 1/8 SOFT STRINGERS
2
3/16 SQ.
1/8 x 1/2
3/16 x 1/2
CLARK Y 1/16 RIBS
3/32 BAMBOO
5
COVER WITH DOUBLE TISSUE
5 1/2
1 1/2
3 1/2
7 1/2
5
1 3/8
14 1/2
2 1/2
2 1/2 M.M.
ELF BIPLANE - by FRANK EHLING - JERSEY CITY N.Y.

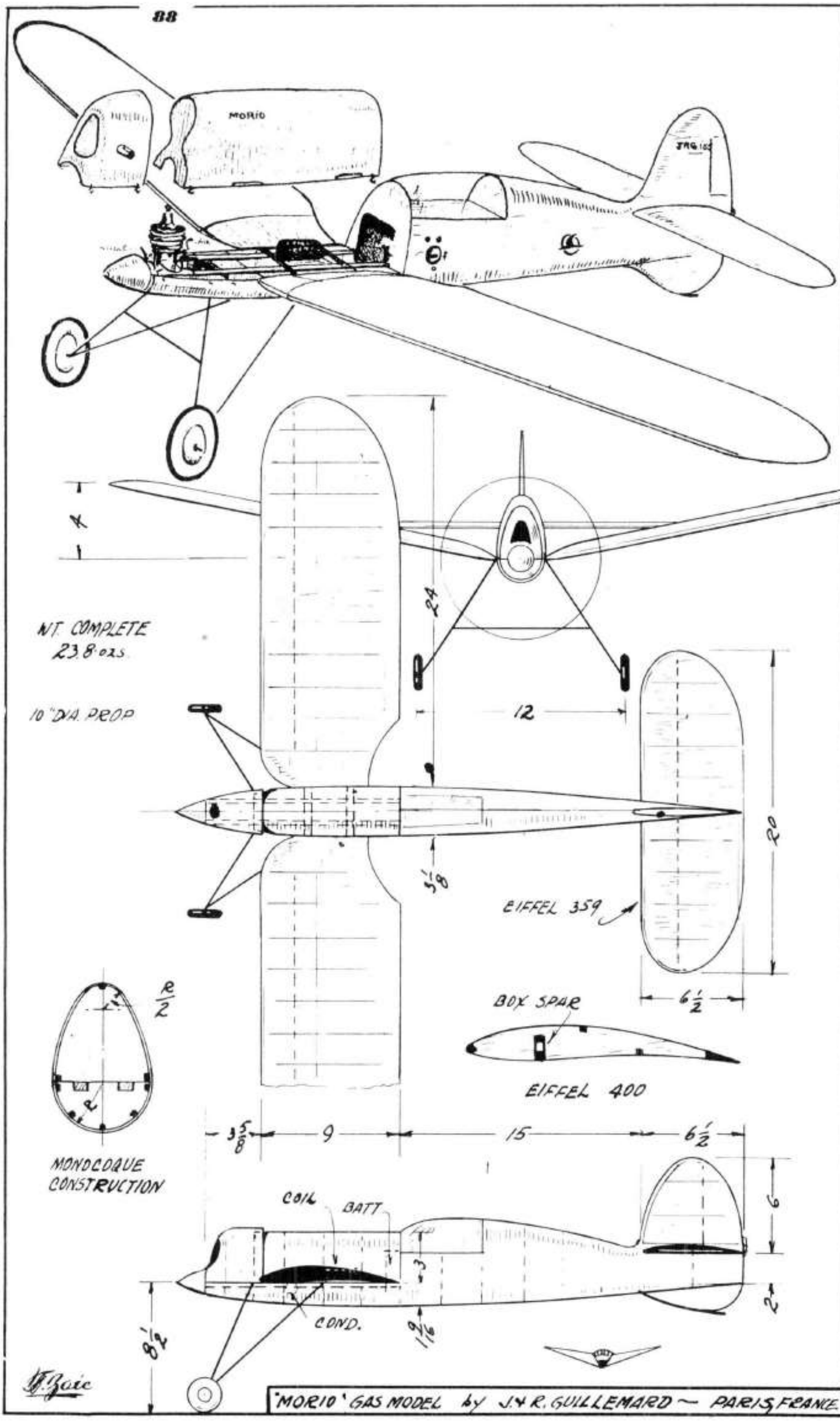

MOTOR
- BRAT -
PROP
9 x 3/8 x 7/8
COVERED WITH
RICE PAPER
5 COATS CLEAR
2 YELLOW
SPRAYED
RED TRIM
F. Zaic
9
WING FIXED WITH
RUBBER LOOPS
1/4 SHEET
LEAVE TOP OPEN FOR
BATTERY & COIL
2 1/2
18
2 3
1/16 SHEET
1/8 x 1/4
3/8 x 1/8
1/8 x 1/4
3/32 WIRE
TAIL SECTION
WT. 20 OZ.
22 1/2
1 1/2 2 1/2 2 1/2
SAN DIEGO AERONEERS
3 3/4
CONSISTANT
5m FLIGHTS
ON 30s RUN
1/8 x 1/2
3/8 x 1/8
1/4 SQ.
3/16 x 1/2
N.A.C.A. 6415 1/16 RIBS
3/16 x 1/16
STRINGERS
5
2 1/2
3/16 x 3/8
6 1/2
1/8 SQ FRAME
1/8 x 1/16
STRINGERS
4 1
3/4
AUTOKNIP
7
3/4
7 3/4
BALSA
6 1/2
12 1/2
5 1/2
2
3
2
2 1/2 MIM.
"13 THE WILDCAT 13" by LEIGHTON WEBB - SAN DIEGO, CALIF


WEIGHTS
SHIP 15 oz.
MOTOR 9 oz
TIMER 2 oz.
MCSL 1 oz.
TOTAL 27 oz
FORMERS 1/16
COVER WITH 1/16 x 1/2 SOFT
NO STRINGERS
1/8 SQ. FRAME
3/16 CLOSER ON FRONT 5
3/64 SHEET
1/16 SQ
3/32 x 5/16
3/32 x 1/4
3/32 x 5/16
M-3
HOLLOWED BALSA COWL
POWER CHUNN
1/8 MOHOGANY PLYWOOD
MOTOR MOUNT
3/64 SHEET
1/16 x 3/8 CAPS
1/4 x 3/8
3/16 x 7/16
1/16 x 15/16
1/16 x 3/8
RAF 32 1/16 RIBS
1/16 MOHOGANY PLYWOOD
CUT FROM 3/64 SHEET
HOLLOWED BALSA
3 1/2 OHLSSON
HAS CLOCKED 2m 55s ON 25s. TIMER
TORPEDO IIIA by LESLIE M. ADAMS — ATLANTA, GA.
F. Zaic

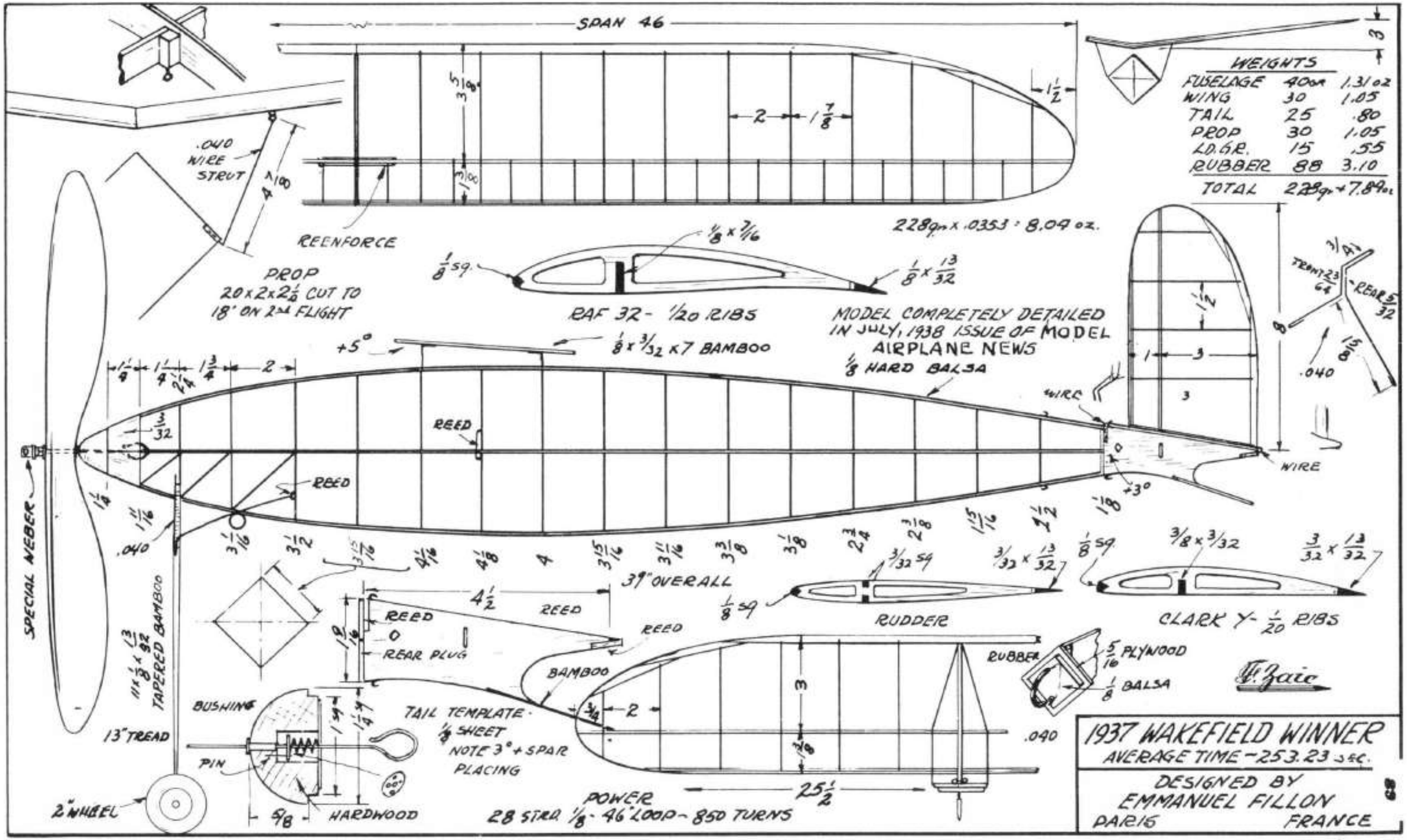

THE BUZZARD
by J. K. COPPAGE – ATLANTA, GA.
WING AREA 560 sq in
MODEL HAS HAD 65 FLIGHTS
WITH ONLY ONE BROKEN PROP
MODEL IS COMPARATIVELY SLOW
BUT IS STABLE IN WIND
INCIDENCES BASED ON LONGERON LINE
FLIGHTS CONTROLLED TO 30 S MOTOR RUN BY CLIPPING TANK-CARBURETOR TUBE
LONGERONS AND BRACES 3/16 SQ. – DIAGONALS 1/8
WT. 29 1/2 OZ. COMPLETE WITH ELF ENGINE
REMOVABLE BATT. COVER
TAIL SURFACES M-2 SECTION 1/16 RIBS
WIRE HINGES
1/16 SHEET FORMER COVERED WITH 1/32
RAF 32
1/16 RIBS
1/16 FORMER
FRAME
1/32 SHEET
1/4 SHEET
1/8 SHEET
1/16 WIRE
PLYWOOD
SILK
ELF PROP
40 sq in
157 sq in
66
24

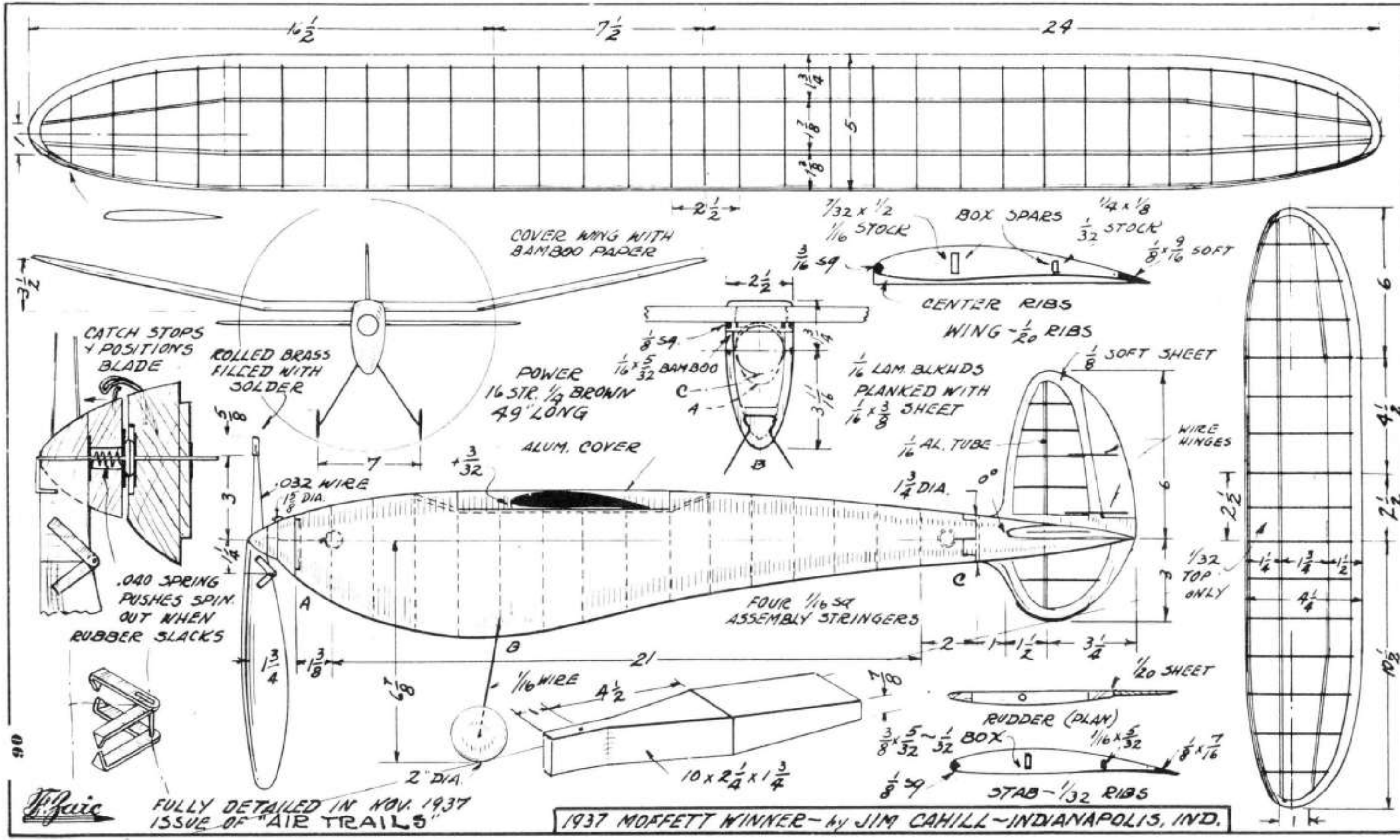


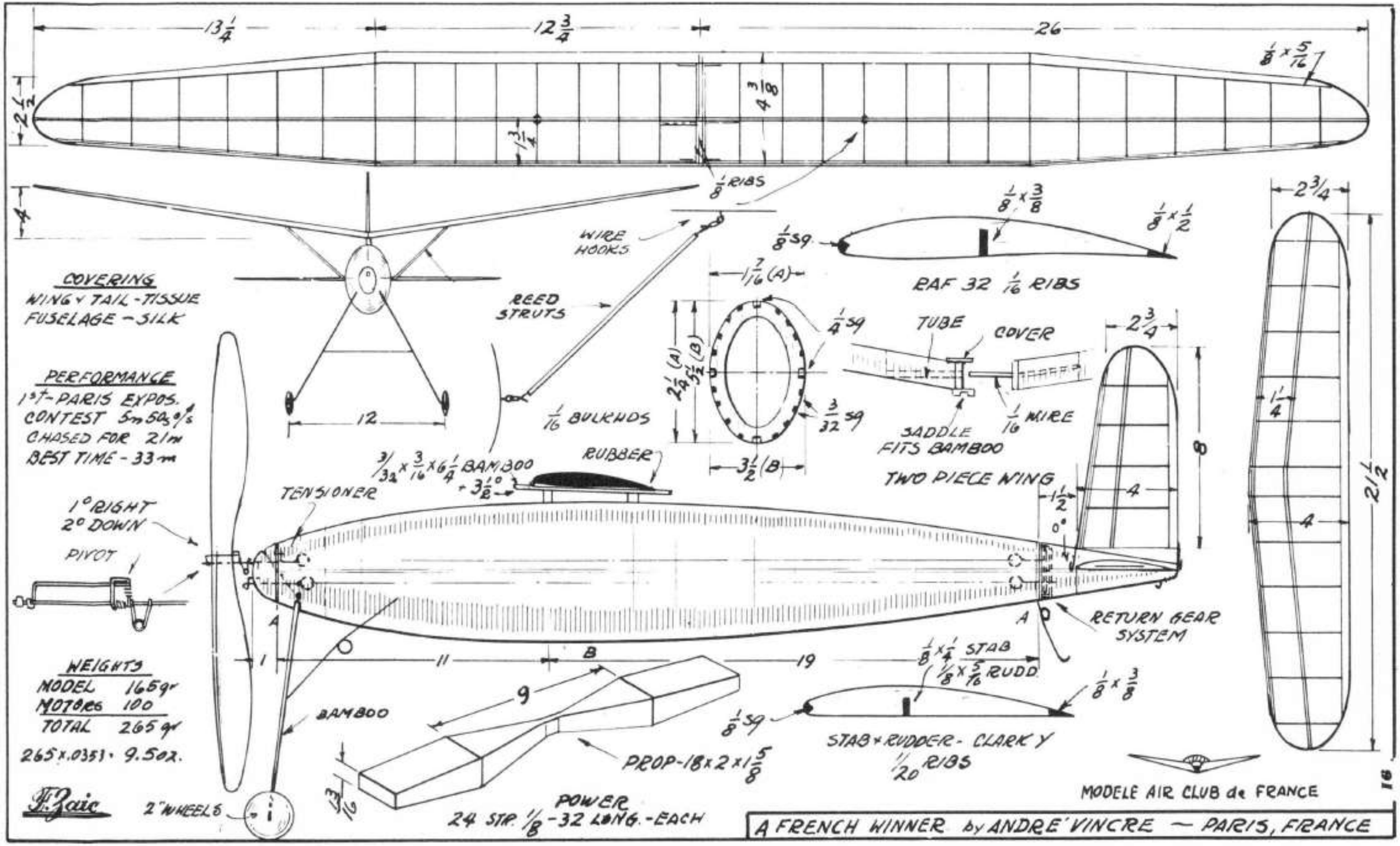
DIHEDRAL
3" SET - BALANCE
SET WHILE WATER
DOPING
6
POWER
TROJAN
10" DIA. PROP
MODEL MADE OVER
80 FLIGHTS WITHOUT
CRACKUPS
3/16 x 3/8
MOTOR MOUNT
3/16 SQ. FRAMEWORK
10
3
1 1/4
1 1/2
1 1/4
27
20
2
3 5/8
4 1/4
3/16 SQ.
1/16 x 1/8
1/8 x 3/8
3/32 x 3/8
1/4 SHEET
1/4 x 1/8
1/4 SHEET
MODIFIED McBRIDE B-7
A-A
4
6
2
4
10
12
A
.045 WIRE
FOR ADJUST.
1/16
WIRE
6 5/8
4 1/8
6 3/8
4 1/2
1/16 WIRE
3 1/2 M+M
ALUM. TUBE
TAMBE
SINGLE WHEELE TROJAN
LEON SHULMAN BROOKLYN, N.Y.



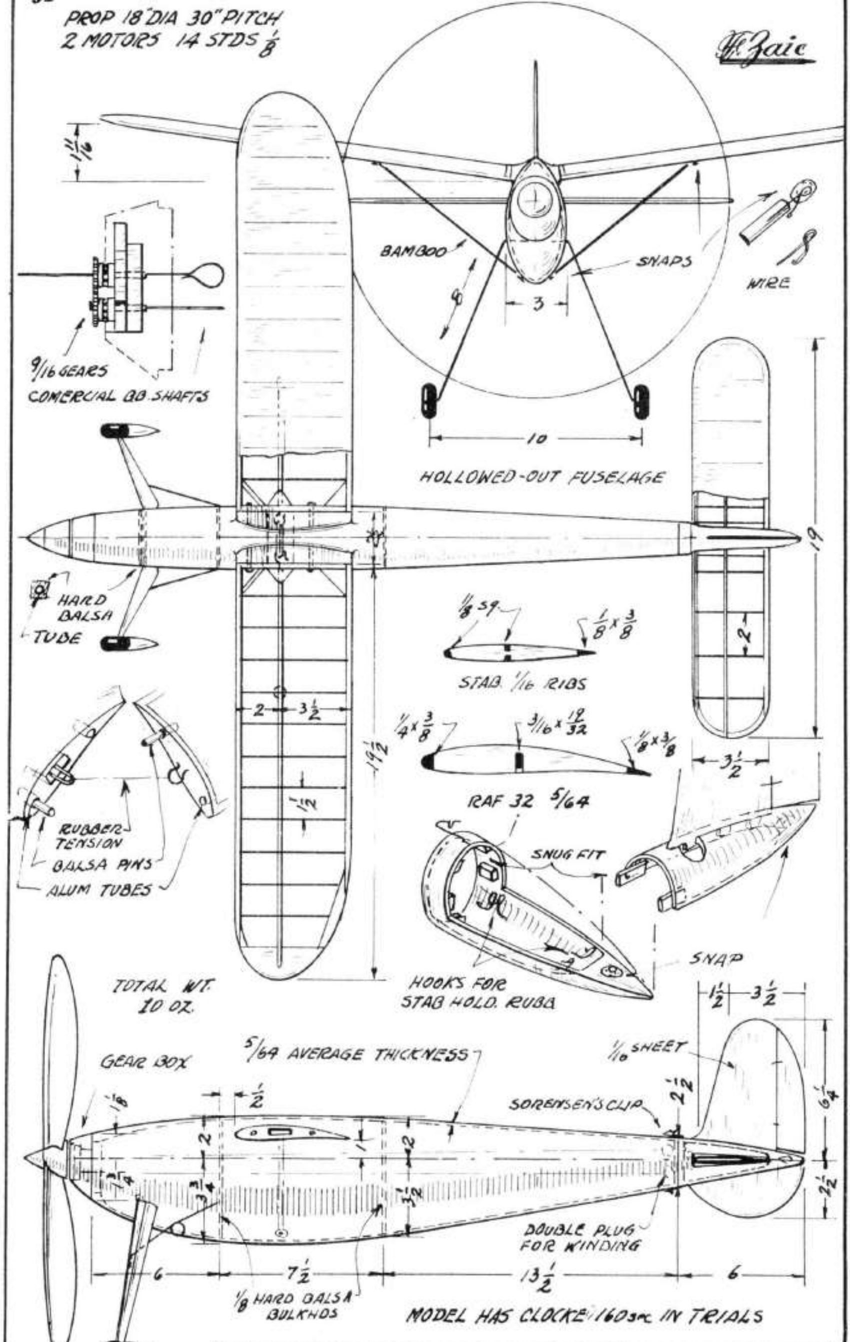
"MORIO" GAS MODEL by J. & R. GUILLEMARD — PARIS, FRANCE


1937 WAKEFIELD WINNER
AVERAGE TIME – 253.23 SEC.
DESIGNED BY
EMMANUEL FILLON
PARIS
FRANCE
SPAN 46
WEIGHTS
FUSELAGE 40gr 1.31 oz
WING 30 1.05
TAIL 25 .80
PROP 30 1.05
LD.GR. 15 .55
RUBBER 88 3.10
TOTAL 228gr 7.89 oz
228gr x .0353 = 8.04 oz.
.040 WIRE STRUT
REENFORCE
PROP
20 x 2 x 2½ CUT TO
18" ON 2nd FLIGHT
RAF 32 – 1/20 RIBS
MODEL COMPLETELY DETAILED
IN JULY, 1938 ISSUE OF MODEL
AIRPLANE NEWS
1/8 HARD BALSA
1/8 x 3/32 x 7 BAMBOO
REED
WIRE
SPECIAL WEBER
TAPERED BAMBOO
39" OVERALL
REAR PLUG
BAMBOO
TAIL TEMPLATE
1/8 SHEET
NOTE 3° + SPAR
PLACING
BUSHING
PIN
HARDWOOD
13" TREAD
2" WHEEL
POWER
28 STRD. 1/8 – 46" LOOP – 850 TURNS
RUDDER
CLARK Y – 1/20 RIBS
RUBBER
5/16 PLYWOOD
1/8 BALSA
F. Zaic

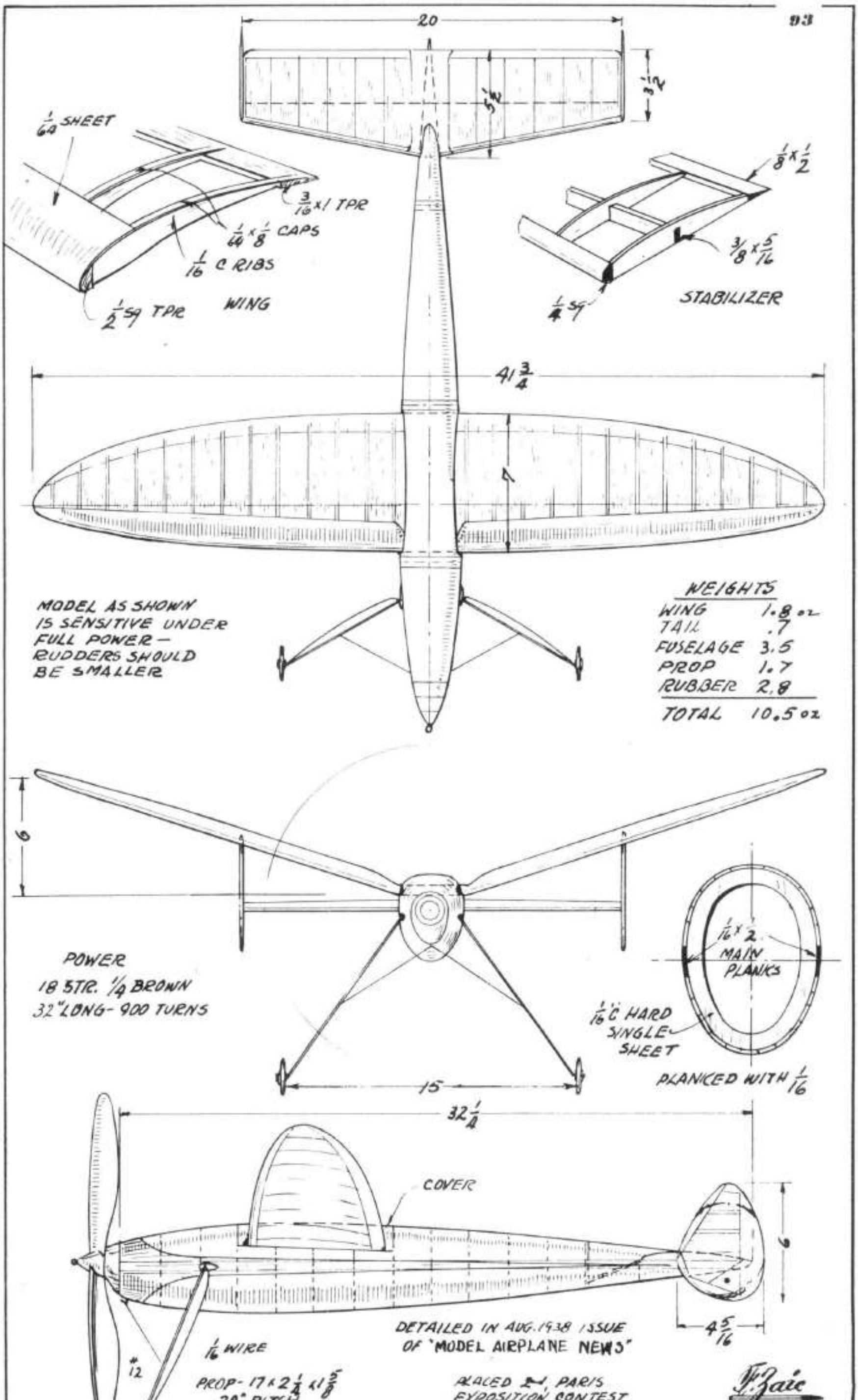

16 1/2
7 1/2
24
1 3/4
7/8
5
1 3/8
2 1/2
7/32 x 1/2
1/16 STOCK
BOX SPARS
1/4 x 1/8
1/32 STOCK
3/16 SQ
1/8 x 9/16 SOFT
CENTER RIBS
WING - 1/20 RIBS
COVER WING WITH BAMBOO PAPER
3 1/2
CATCH STOPS & POSITIONS BLADE
ROLLED BRASS FILLED WITH SOLDER
POWER 16 STR. 1/4 BROWN 49" LONG
1/8 SQ.
1/16 x 5/32 BAMBOO
3/4
3 1/16
1/16 LAM. BLKHDS PLANKED WITH 1/16 x 3/8 SHEET
1/8 SOFT SHEET
WIRE HINGES
1/16 AL. TUBE
1 3/4 DIA.
ALUM. COVER
+3/32
7
.032 WIRE
1 5/8 DIA.
3
1 1/4
.040 SPRING PUSHES SPIN. OUT WHEN RUBBER SLACKS
FOUR 1/16 SQ ASSEMBLY STRINGERS
1/32 TOP ONLY
2 1/2
4 1/4
1/4
1 3/4
1/2
6
4 1/2
2 1/2
10 1/2
1 3/4
1 3/8
21
2
1
1 1/2
3 1/4
1/16 WIRE
4 1/2
1/20 SHEET
RUDDER (PLAN)
3/8 x 5/32 ~ 1/32 BOX
1/16 x 5/32
1/8 x 7/16
1/8 SQ
STAB - 1/32 RIBS
10 x 2 1/4 x 1 3/4
2" DIA.
FULLY DETAILED IN NOV. 1937 ISSUE OF "AIR TRAILS"
1937 MOFFETT WINNER - by JIM CAHILL - INDIANAPOLIS, IND.

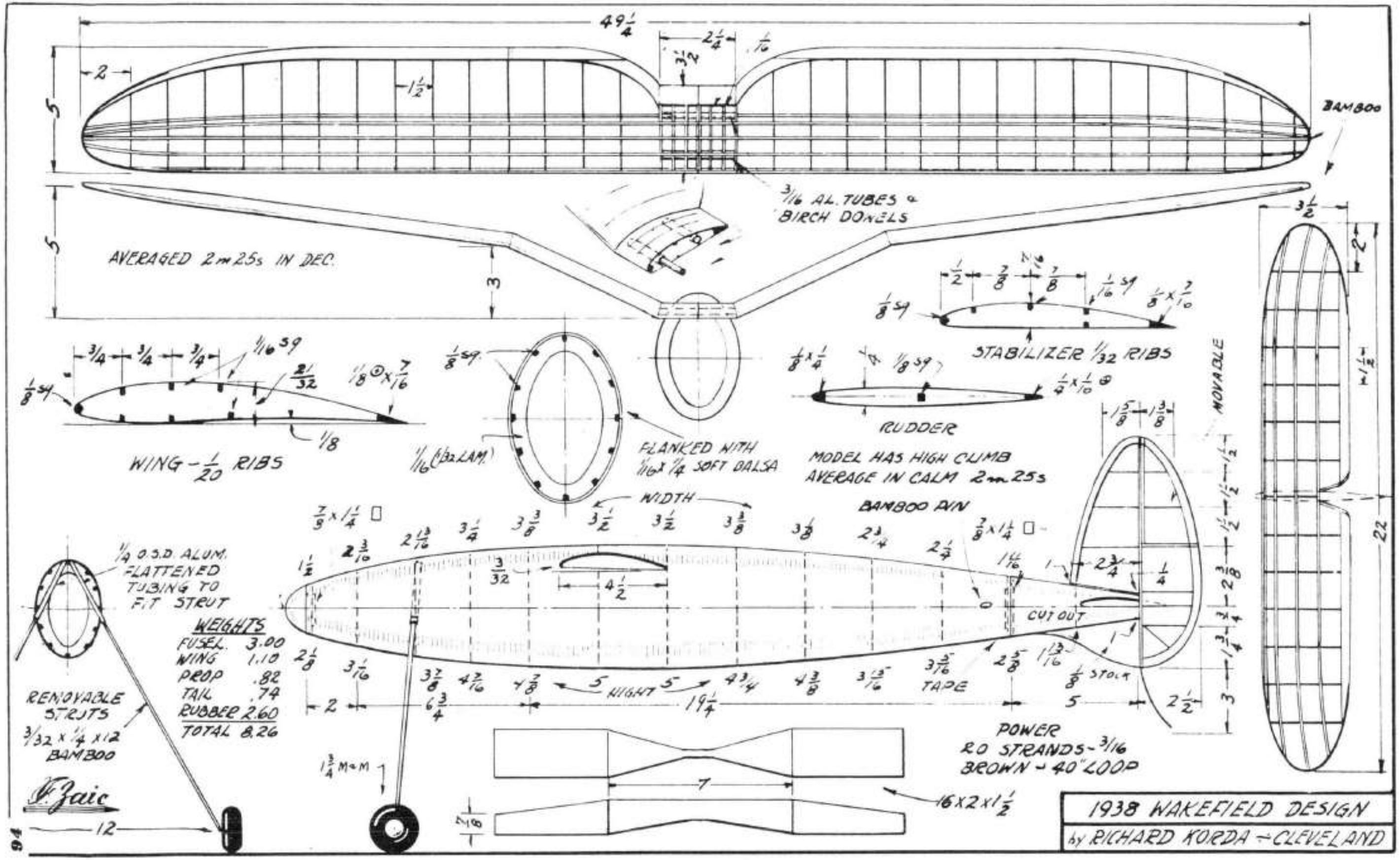


COVERING
WING + TAIL - TISSUE
FUSELAGE - SILK
PERFORMANCE
1st - PARIS EXPOS. CONTEST 5m 50s
CHASED FOR 21m
BEST TIME - 33 m
WEIGHTS
MODEL 165 gr
MOTORS 100
TOTAL 265 gr
265 x .0353 = 9.5 oz.
1° RIGHT 2° DOWN
PIVOT
TENSIONER
BAMBOO
2" WHEELS
REED STRUTS
WIRE HOOKS
1/16 BULKHDS
RUBBER
RAF 32 1/16 RIBS
TUBE
COVER
SADDLE FITS BAMBOO
1/16 WIRE
TWO PIECE WING
RETURN GEAR SYSTEM
STAB + RUDDER - CLARK Y 1/20 RIBS
PROP - 18 x 2 x 1 5/8
POWER
24 STR. 1/8 - 32 LONG. - EACH
MODELE AIR CLUB de FRANCE
A FRENCH WINNER by ANDRE' VINCRE — PARIS, FRANCE

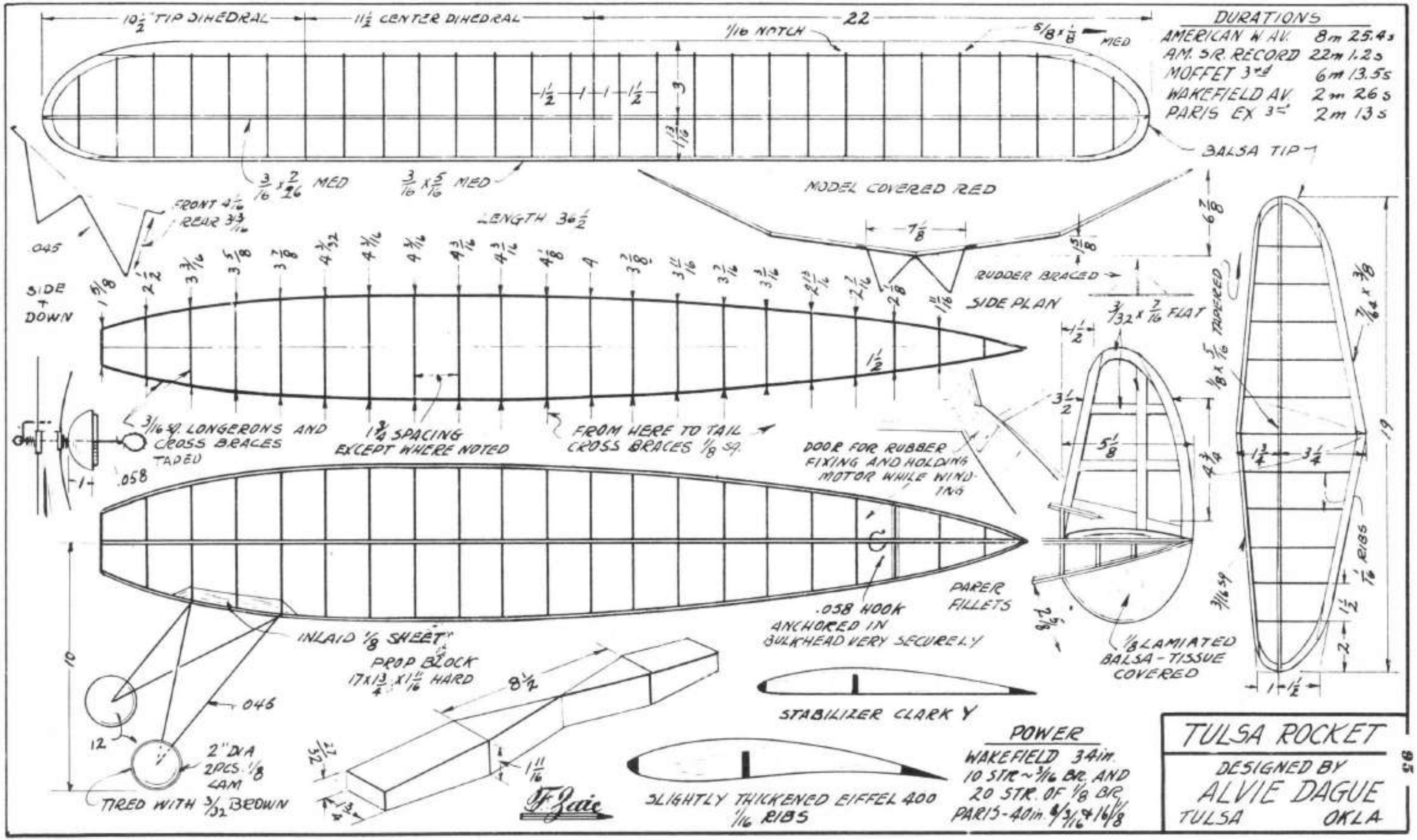


A 1937 WAKEFIELD ENTRY by ALFRED Van WYMERSCH – BRUSSELS

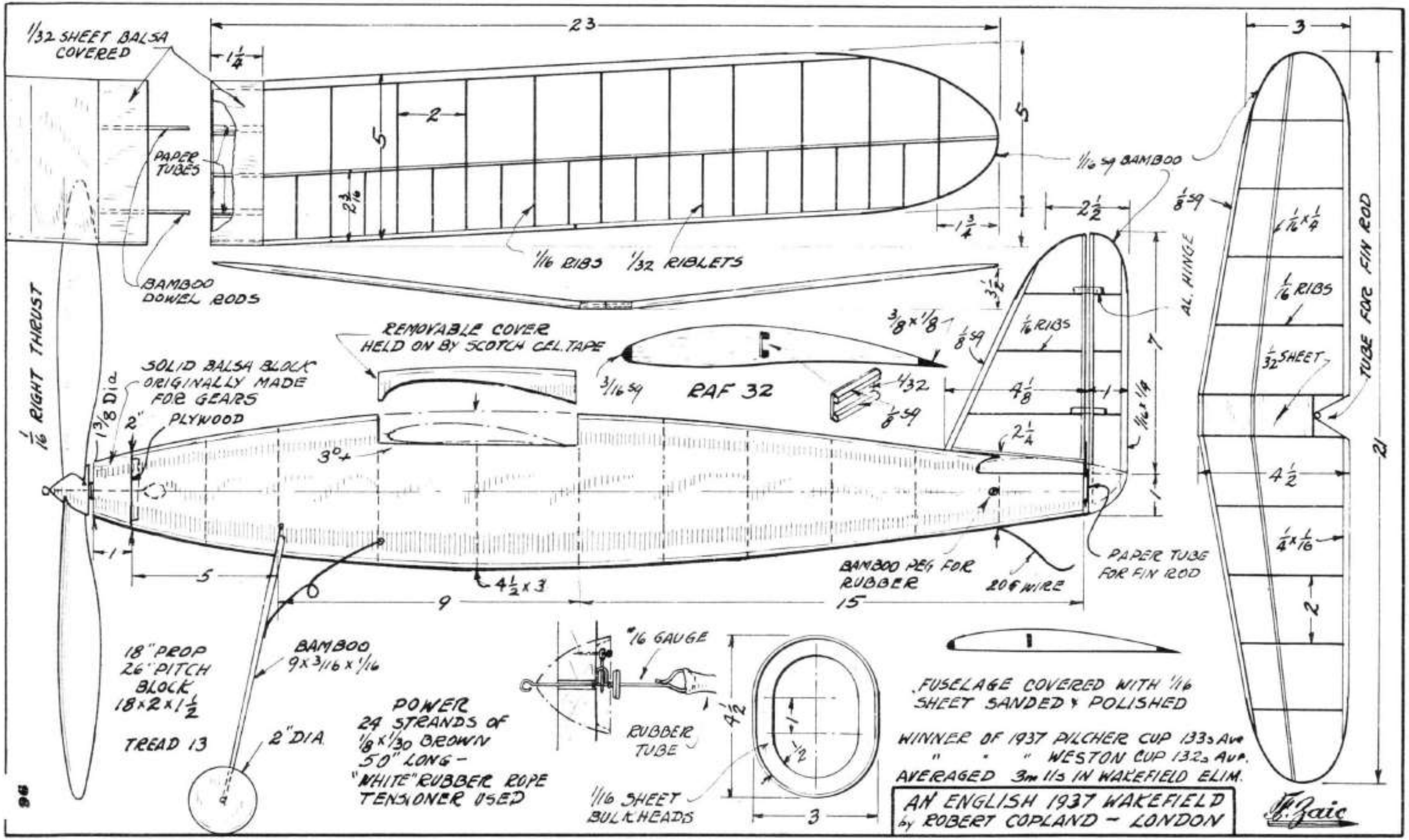

20
3 1/2
5 1/2
1/64 SHEET
3/16 x 1 TPR
1/4 x 1/8 CAPS
1/16 C RIBS
1/2 SQ TPR
WING
1/8 x 1/2
3/8 x 5/16
1/4 SQ
STABILIZER
41 3/4
7
MODEL AS SHOWN
IS SENSITIVE UNDER
FULL POWER —
RUDDERS SHOULD
BE SMALLER
WEIGHTS
WING 1.8 oz
TAIL .7
FUSELAGE 3.5
PROP 1.7
RUBBER 2.8
TOTAL 10.5 oz
6
POWER
18 STR. 1/4 BROWN
32" LONG - 900 TURNS
1/16 x 2
MAIN
PLANKS
1/16 C HARD
SINGLE
SHEET
PLANKED WITH 1/16
15
32 1/4
COVER
6
4 5/16
DETAILED IN AUG. 1938 ISSUE
OF "MODEL AIRPLANE NEWS"
1/16 WIRE
#12
PROP - 17 x 2 1/4 x 1 5/8
28" PITCH
PLACED 2nd, PARIS
EXPOSITION CONTEST
F. Zaic
1937 WAKEFIELD ENTRY by FRANK ZAIC — NEW YORK N.Y.



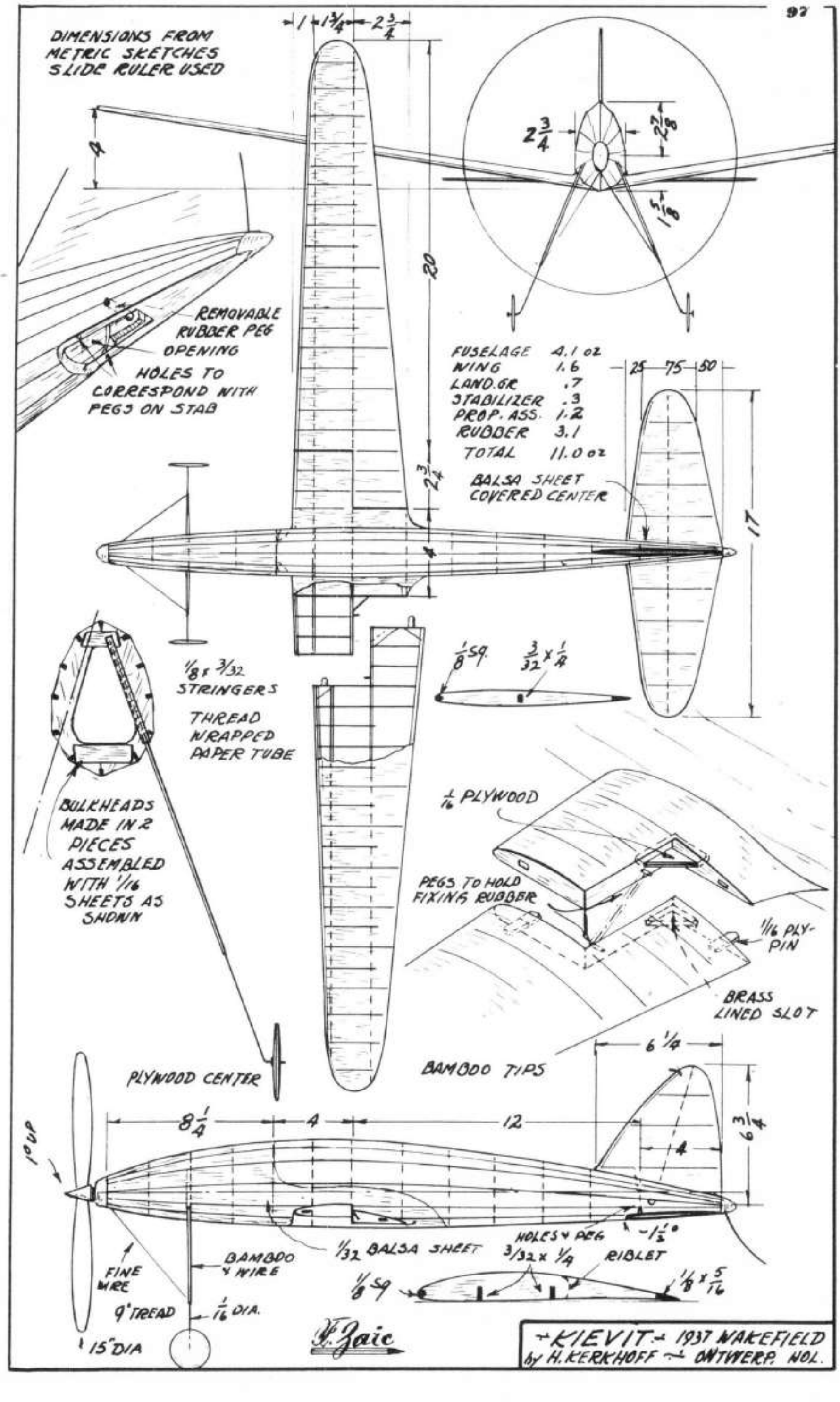
AVERAGED 2 m 25 s IN DEC.
BAMBOO
3/16 AL. TUBES & BIRCH DOWELS
WING - 1/20 RIBS
FLANKED WITH 1/16 x 1/4 SOFT BALSA
STABILIZER 1/32 RIBS
RUDDER
MOVABLE
MODEL HAS HIGH CLIMB
AVERAGE IN CALM 2 m 25 s
WIDTH
BAMBOO PIN
CUT OUT
HIGHT
TAPE
1/4 O.S.D. ALUM. FLATTENED TUBING TO FIT STRUT
WEIGHTS
FUSEL. 3.00
WING 1.10
PROP .82
TAIL .74
RUBBER 2.60
TOTAL 8.26
REMOVABLE STRUTS
3/32 x 1/4 x 12 BAMBOO
POWER
20 STRANDS - 3/16
BROWN - 40" LOOP
16 x 2 x 1 1/2
F. Zaic
1938 WAKEFIELD DESIGN
by RICHARD KORDA - CLEVELAND



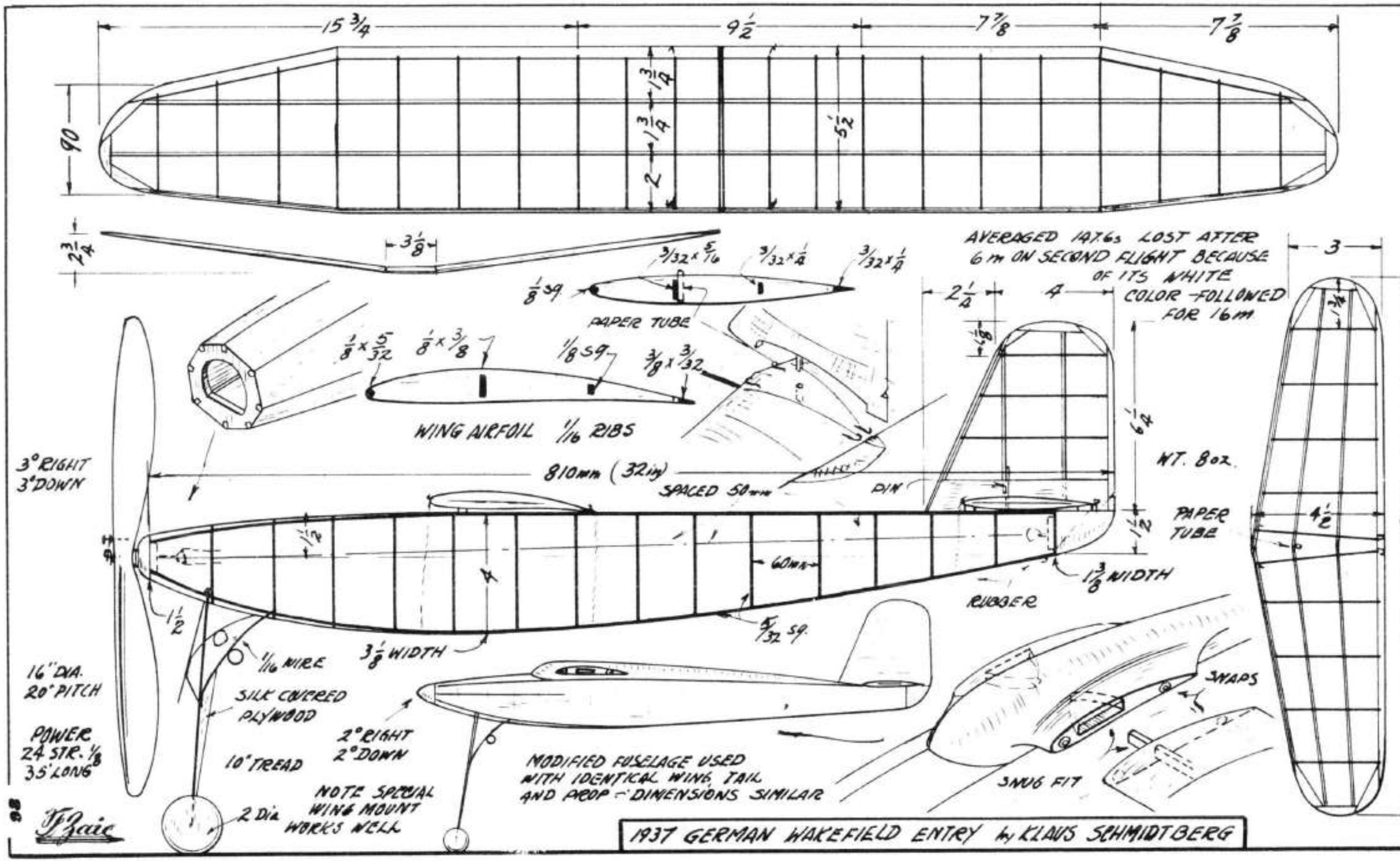
DURATIONS
AMERICAN W AV. 8m 25.4s
AM. SR. RECORD 22m 1.2s
MOFFET 3rd 6m 13.5s
WAKEFIELD AV. 2m 26s
PARIS EX 3rd 2m 13s
10½ TIP DIHEDRAL
11½ CENTER DIHEDRAL
22
1/16 NOTCH
5/8 x 1/8 MED
BALSA TIP
3/16 x 7/16 MED
3/16 x 5/16 MED
MODEL COVERED RED
FRONT 4 1/16
REAR 3 3/16
LENGTH 36½
.045
SIDE + DOWN
RUDDER BRACED
SIDE PLAN
3/32 x 7/16 FLAT
1/8 x 5/16 TAPERED
7/64 x 3/8
3/16 SQ. LONGERONS AND CROSS BRACES TAPED
1¾ SPACING EXCEPT WHERE NOTED
FROM HERE TO TAIL CROSS BRACES 1/8 SQ.
DOOR FOR RUBBER FIXING AND HOLDING MOTOR WHILE WINDING
.058
PAPER FILLETS
.058 HOOK ANCHORED IN BULKHEAD VERY SECURELY
1/8 LAMIATED BALSA - TISSUE COVERED
1/16 RIBS
3/16 SQ
INLAID 1/8 SHEET
PROP BLOCK 17 X 1¾ X 1 11/16 HARD
8½
.046
2" DIA 2PCS. 1/8 LAM
TIRED WITH 3/32 BROWN
STABILIZER CLARK Y
SLIGHTLY THICKENED EIFFEL 400 1/16 RIBS
POWER
WAKEFIELD 34in. 10 STR ~ 3/16 BR. AND 20 STR. OF 1/8 BR.
PARIS - 40in. 6/3/16 & 16/1/8
TULSA ROCKET
DESIGNED BY
ALVIE DAGUE
TULSA OKLA



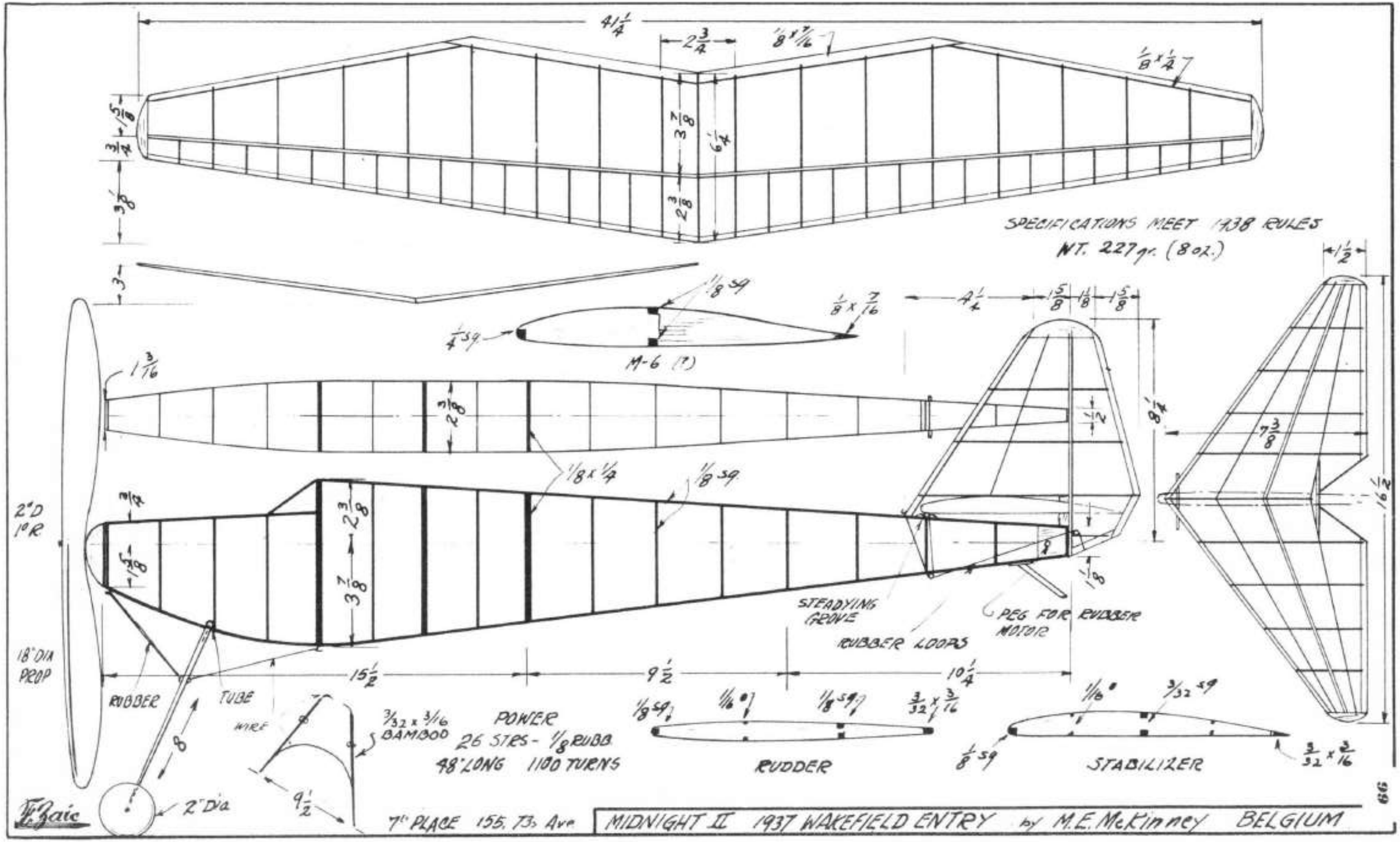
1/32 SHEET BALSA COVERED
PAPER TUBES
BAMBOO DOWEL RODS
23
1 1/4
5
2
2 3/16
1/16 RIBS
1/32 RIBLETS
1 3/4
1/16 SQ BAMBOO
2 1/2
3 1/2
AL. HINGE
3/8 x 1/8
1/8 SQ
1/16 RIBS
7
4 1/8
1
1/16 x 1/4
2 1/4
1
3
1/8 SQ
1/16 x 1/4
1/16 RIBS
1/32 SHEET
TUBE FOR FIN ROD
21
4 1/2
1/4 x 1/16
2
1/16 RIGHT THRUST
REMOVABLE COVER HELD ON BY SCOTCH CEL. TAPE
SOLID BALSA BLOCK ORIGINALLY MADE FOR GEARS
1 3/8 Dia
2"
PLYWOOD
3/16 SQ
RAF 32
1/32
1/8 SQ
3°+
1
5
4 1/2 x 3
9
15
BAMBOO PEG FOR RUBBER
20 G WIRE
PAPER TUBE FOR FIN ROD
18" PROP
26" PITCH
BLOCK
18 x 2 x 1 1/2
TREAD 13
BAMBOO
9 x 3/16 x 1/16
2" DIA.
POWER
24 STRANDS OF
1/8 x 1/30 BROWN
50" LONG –
"WHITE" RUBBER ROPE
TENSIONER USED
#16 GAUGE
RUBBER TUBE
1/16 SHEET BULKHEADS
4 1/2
1
1/2
3
FUSELAGE COVERED WITH 1/16 SHEET SANDED & POLISHED
WINNER OF 1937 PILCHER CUP 133s Avg.
" " " WESTON CUP 132s Avg.
AVERAGED 3m 11s IN WAKEFIELD ELIM.
AN ENGLISH 1937 WAKEFIELD
by ROBERT COPLAND – LONDON
F. Zaic



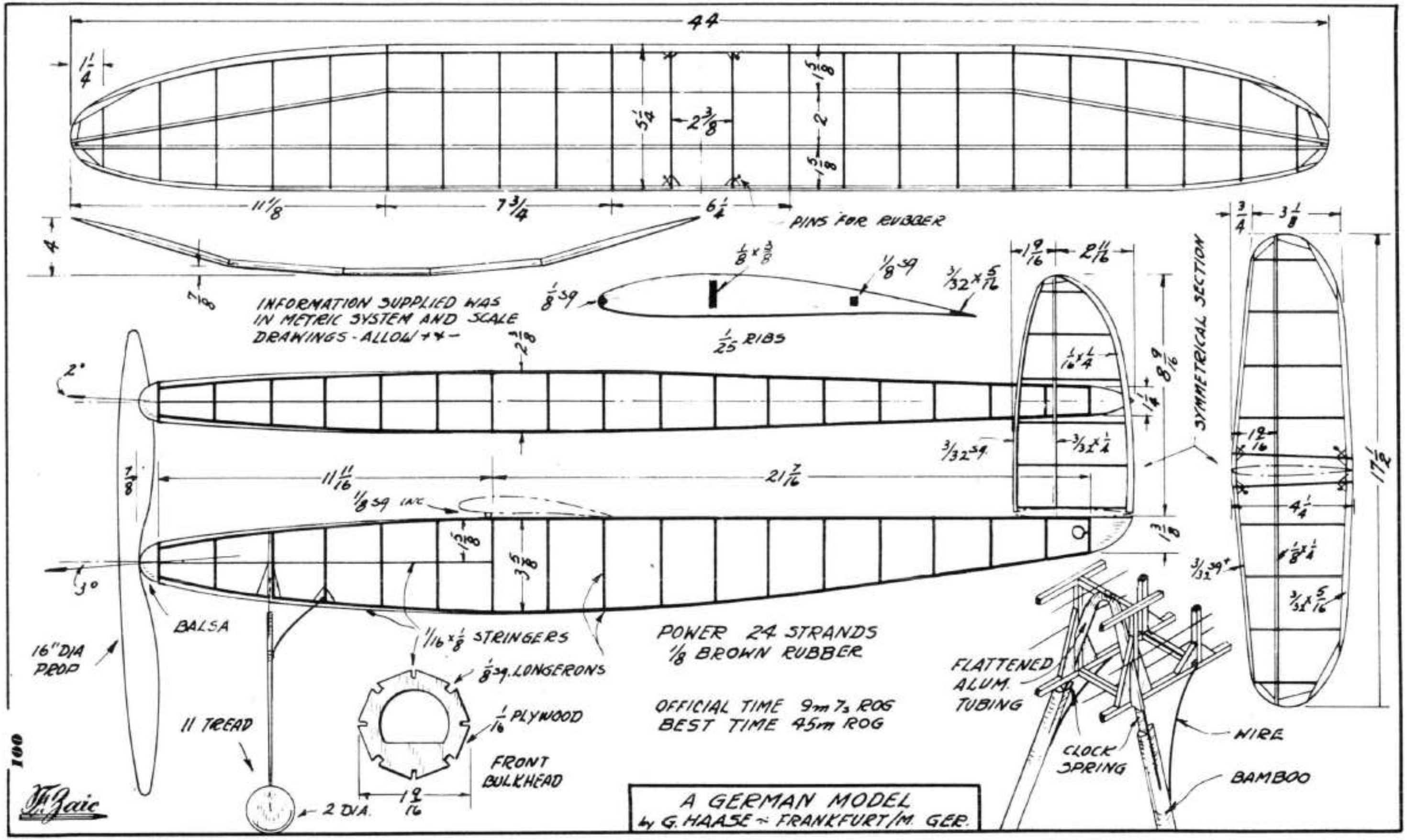
DIMENSIONS FROM METRIC SKETCHES SLIDE RULER USED
REMOVABLE RUBBER PEG
OPENING
HOLES TO CORRESPOND WITH PEGS ON STAB
FUSELAGE 4.1 oz
WING 1.6
LAND.GR .7
STABILIZER .3
PROP. ASS. 1.2
RUBBER 3.1
TOTAL 11.0 oz
BALSA SHEET COVERED CENTER
1/8 x 3/32 STRINGERS
THREAD WRAPPED PAPER TUBE
BULKHEADS MADE IN 2 PIECES ASSEMBLED WITH 1/16 SHEETS AS SHOWN
1/16 PLYWOOD
PEGS TO HOLD FIXING RUBBER
1/16 PLY-PIN
BRASS LINED SLOT
BAMBOO TIPS
PLYWOOD CENTER
10° UP
1/32 BALSA SHEET
HOLES & PEG
RIBLET
BAMBOO & WIRE
FINE WIRE
9" TREAD
1/16 DIA.
15" DIA
F. Zaic
KIEVIT 1937 WAKEFIELD
by H. KERKHOFF ANTWERP, HOL.

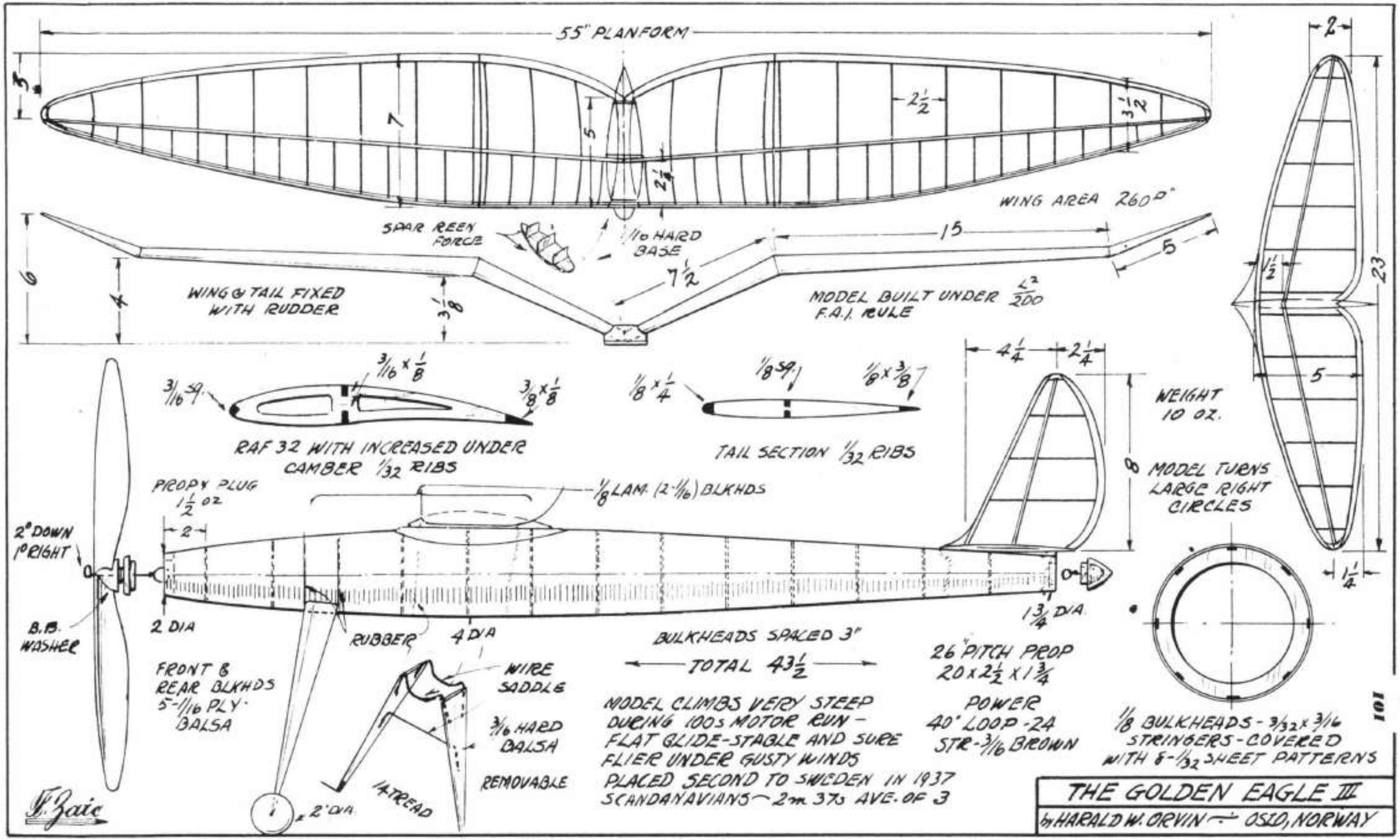


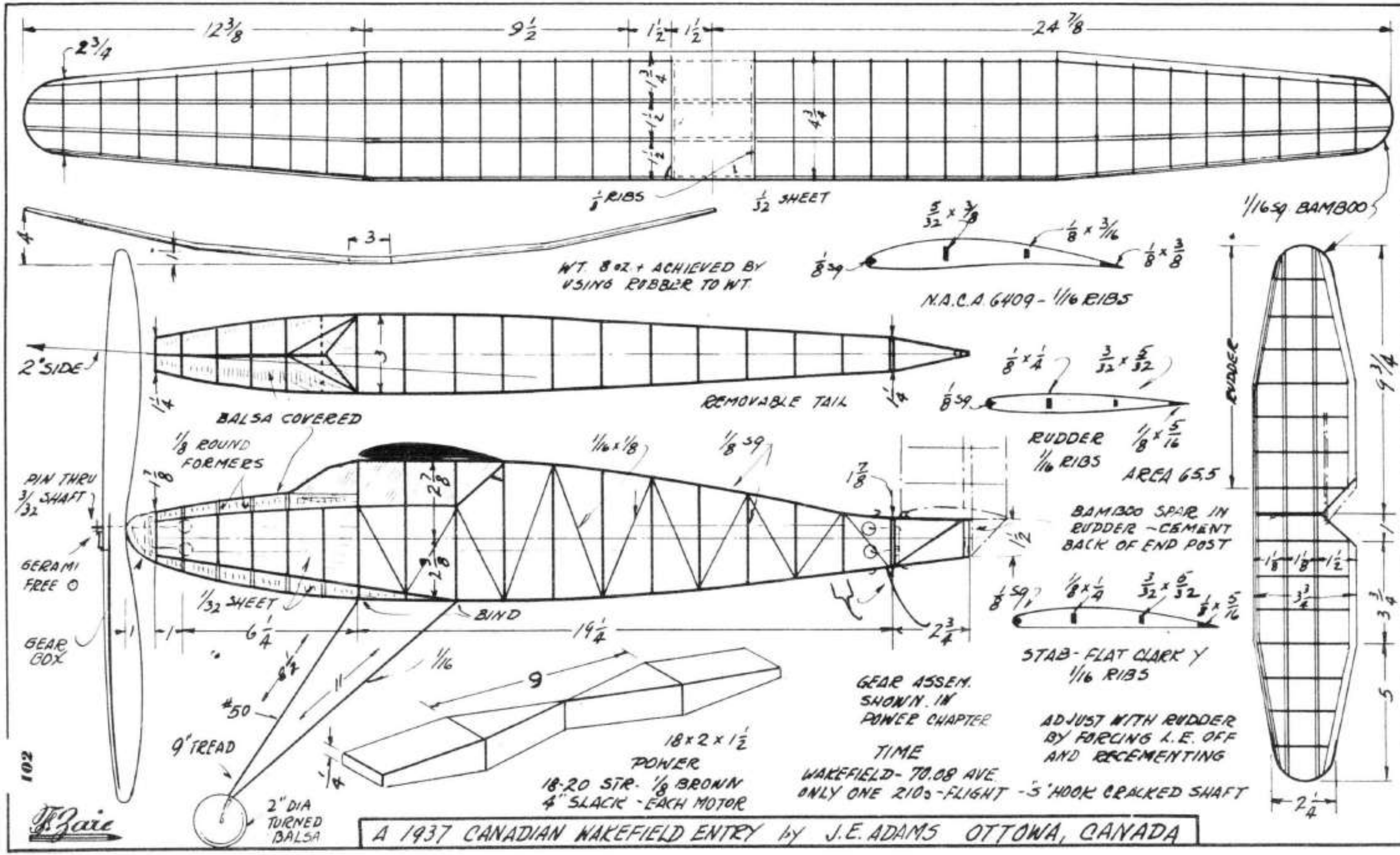
AVERAGED 147.6s LOST AFTER 6 m ON SECOND FLIGHT BECAUSE OF ITS WHITE COLOR - FOLLOWED FOR 16 m
WING AIRFOIL 1/16 RIBS
PAPER TUBE
3° RIGHT 3° DOWN
810mm (32in)
SPACED 50mm
WT. 8oz.
RUBBER
16" DIA. 20" PITCH
POWER 24 STR. 1/8 35' LONG
SILK COVERED PLYWOOD
1/16 WIRE
10" TREAD
2° RIGHT 2° DOWN
NOTE SPECIAL WING MOUNT WORKS WELL
2 Dia
MODIFIED FUSELAGE USED WITH IDENTICAL WING, TAIL AND PROP - DIMENSIONS SIMILAR
SNUG FIT
SNAPS
1937 GERMAN WAKEFIELD ENTRY by KLAUS SCHMIDTBERG

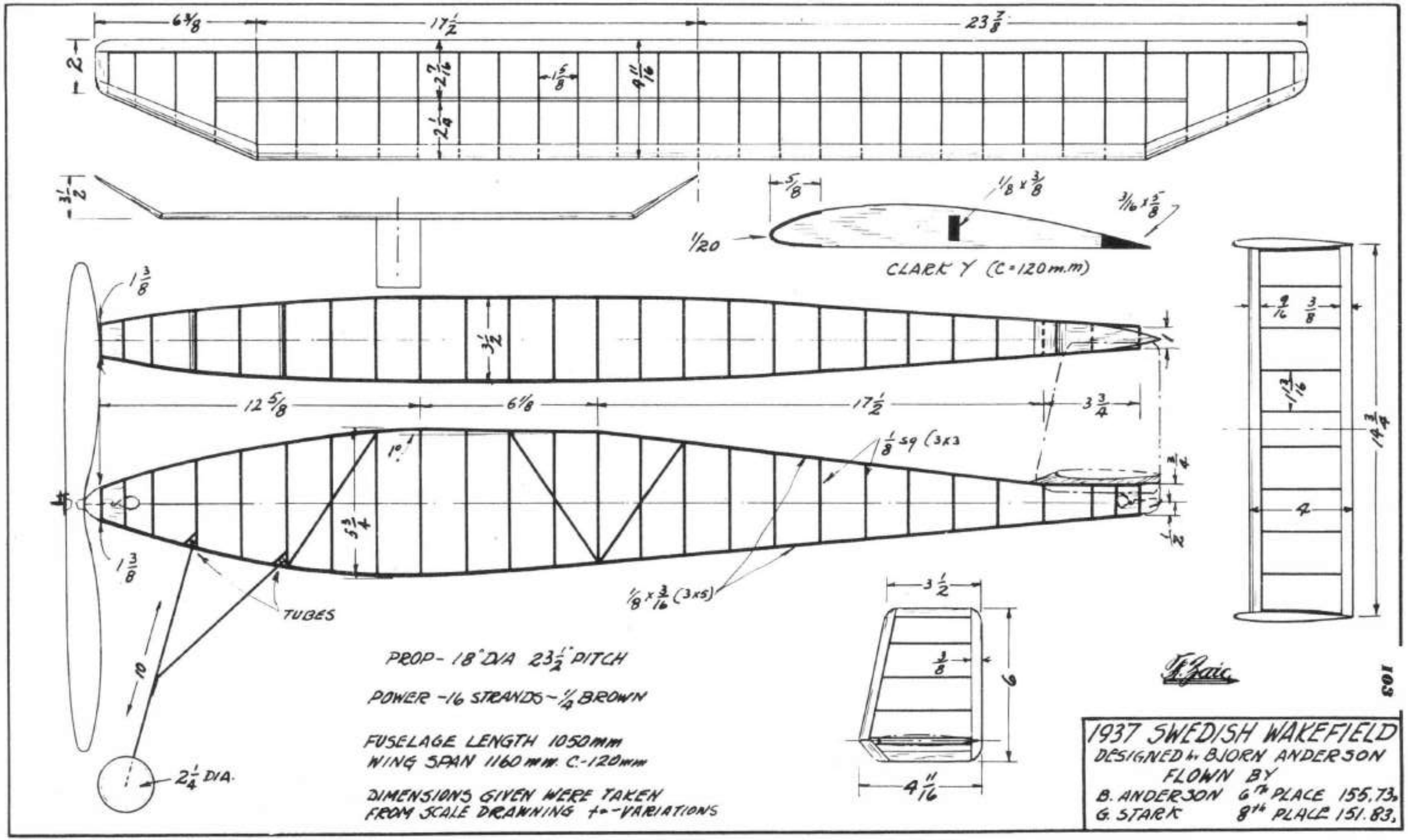


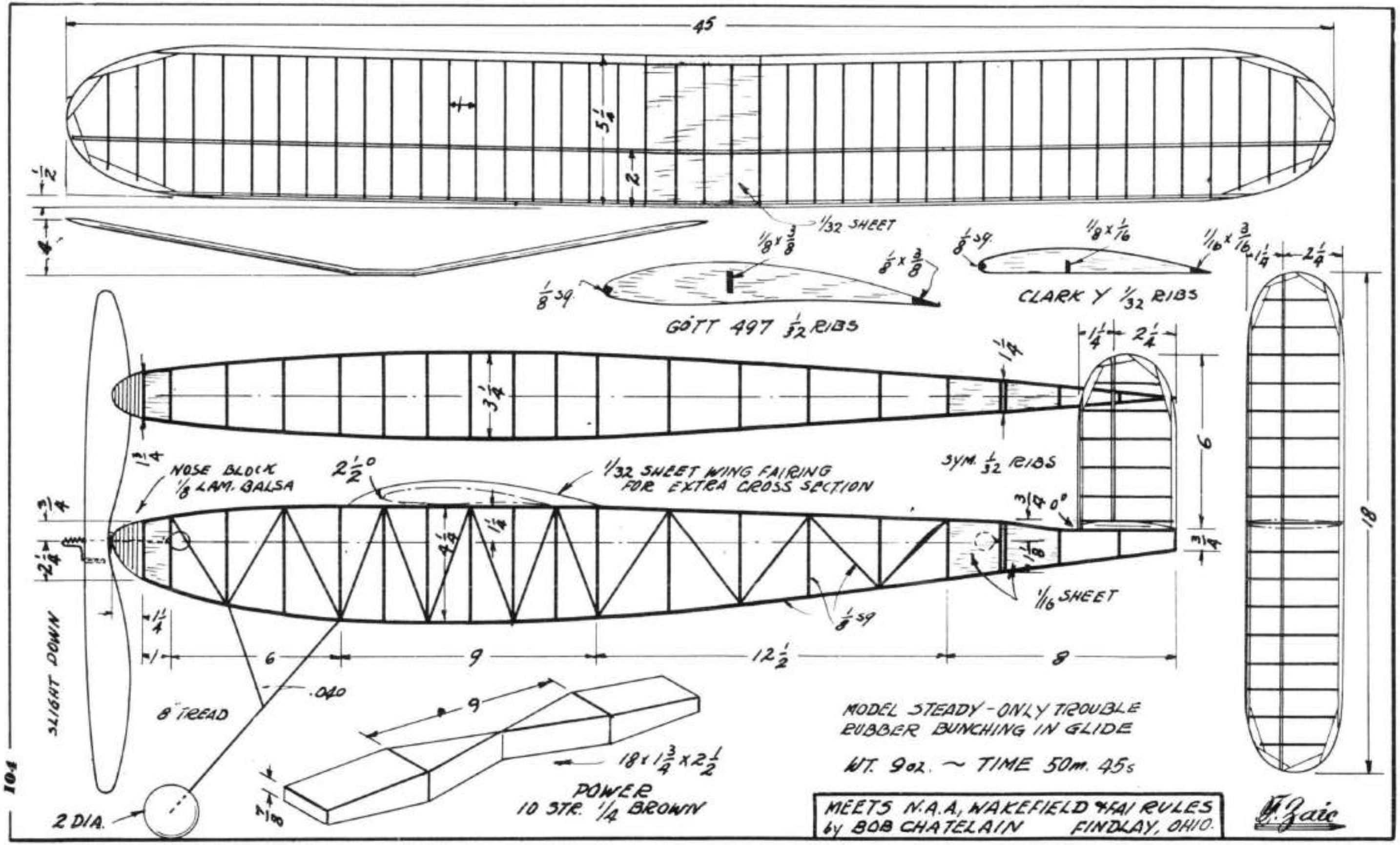
SPECIFICATIONS MEET 1938 RULES
WT. 227 gr. (8 oz.)
M-6 (?)
STEADYING GROOVE
RUBBER LOOPS
PEG FOR RUBBER MOTOR
2"D 1°R
18" DIA PROP
RUBBER
TUBE
WIRE
3/32 x 3/16 BAMBOO
2" Dia
POWER
26 STRS - 1/8 RUBB.
48" LONG 1100 TURNS
RUDDER
STABILIZER
7th PLACE 155.73s Ave.
MIDNIGHT II 1937 WAKEFIELD ENTRY by M.E. McKinney BELGIUM

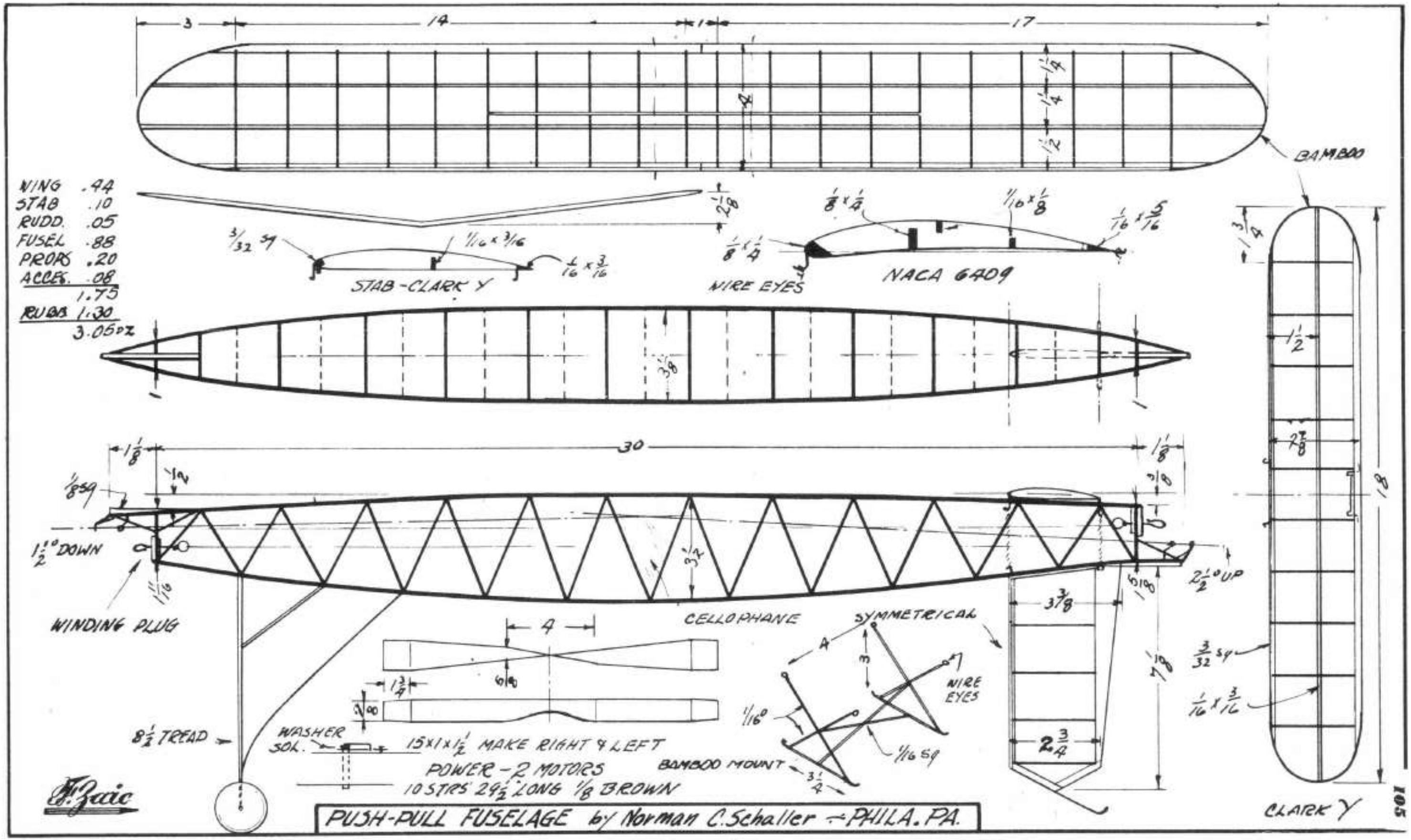

44
PINS FOR RUBBER
INFORMATION SUPPLIED WAS
IN METRIC SYSTEM AND SCALE
DRAWINGS - ALLOW +*-
RIBS
SYMMETRICAL SECTION
BALSA
16" DIA
PROP
STRINGERS
SQ. LONGERONS
PLYWOOD
FRONT
BULKHEAD
11 TREAD
2 DIA.
POWER 24 STRANDS
1/8 BROWN RUBBER
OFFICIAL TIME 9m 7s ROG
BEST TIME 45m ROG
FLATTENED
ALUM.
TUBING
CLOCK
SPRING
WIRE
BAMBOO
A GERMAN MODEL
by G. HAASE ~ FRANKFURT/M. GER.


55" PLANFORM
WING AREA 260□"
SPAR REENFORCE
1/16 HARD BASE
WING & TAIL FIXED WITH RUDDER
MODEL BUILT UNDER L²/200 F.A.I. RULE
RAF 32 WITH INCREASED UNDER CAMBER 1/32 RIBS
TAIL SECTION 1/32 RIBS
WEIGHT 10 OZ.
MODEL TURNS LARGE RIGHT CIRCLES
PROP & PLUG 1½ OZ
1/8 LAM. (2-1/16) BLKHDS
2° DOWN 1° RIGHT
B.B. WASHER
2 DIA
RUBBER
4 DIA
1¾ DIA.
BULKHEADS SPACED 3"
TOTAL 43½
26" PITCH PROP 20 x 2½ x 1¾
FRONT & REAR BLKHDS 5-1/16 PLY-BALSA
WIRE SADDLE
3/16 HARD BALSA
REMOVABLE
14 TREAD
2" DIA
MODEL CLIMBS VERY STEEP DURING 100s MOTOR RUN - FLAT GLIDE - STABLE AND SURE FLIER UNDER GUSTY WINDS
PLACED SECOND TO SWEDEN IN 1937 SCANDANAVIANS ~ 2m 37s AVE. OF 3
POWER 40" LOOP - 24 STR - 3/16 BROWN
1/8 BULKHEADS - 3/32 x 3/16 STRINGERS - COVERED WITH 8-1/32 SHEET PATTERNS
THE GOLDEN EAGLE III
by HARALD W. ORVIN ~ OSLO, NORWAY
F. Zaic

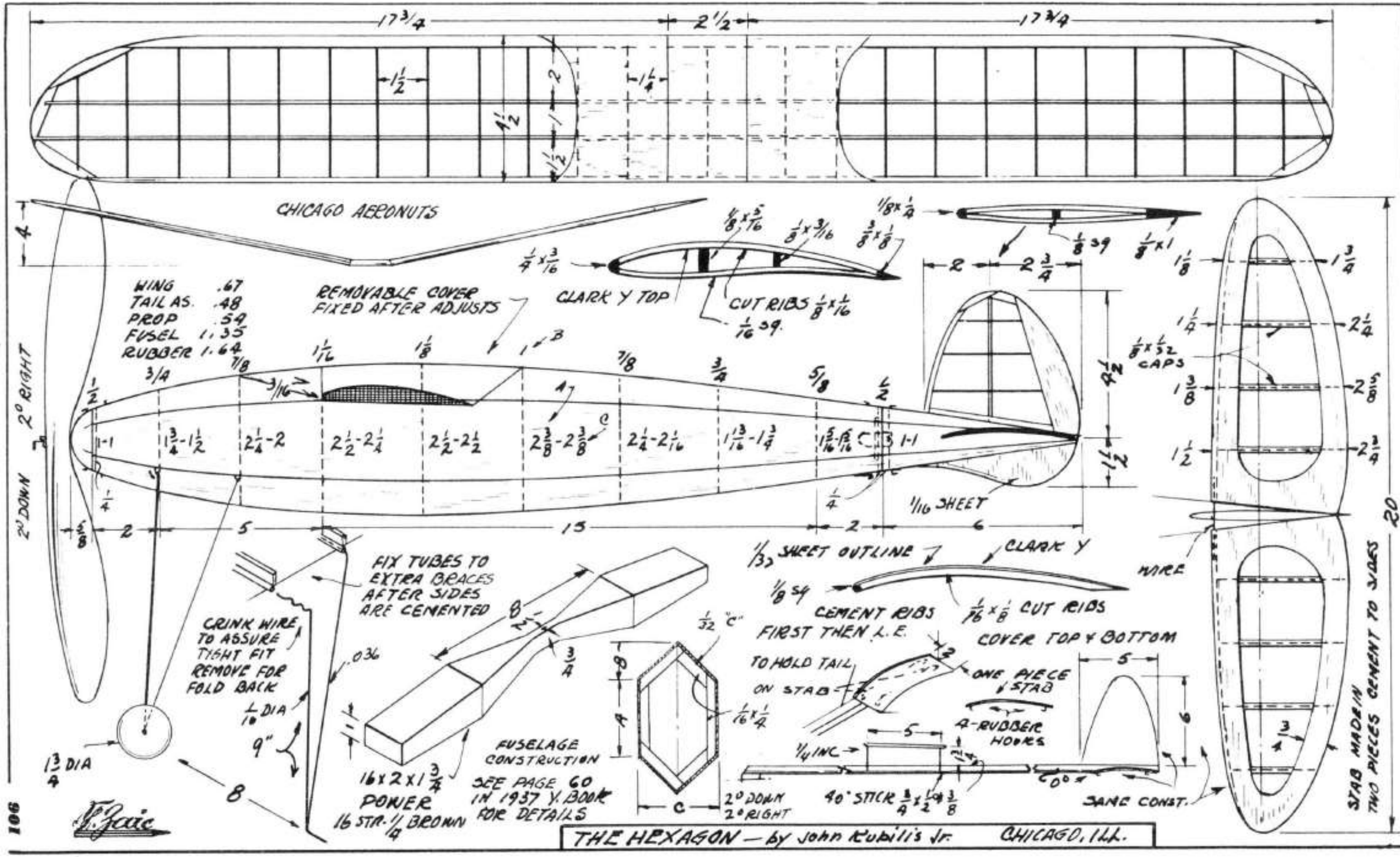

12 3/8
9 1/2
1 1/2
1 1/2
24 7/8
2 3/4
4 3/4
1/8 RIBS
1/32 SHEET
1/16 SQ BAMBOO
5/32 x 3/8
1/8 x 3/16
1/8 SQ
1/8 x 3/8
WT. 8 OZ + ACHIEVED BY USING RUBBER TO WT.
N.A.C.A. 6409 - 1/16 RIBS
2" SIDE
REMOVABLE TAIL
1/8 x 1/4
3/32 x 5/32
1/8 SQ
1/8 x 5/16
BALSA COVERED
1/8 ROUND FORMERS
1/16 x 1/8
1/8 SQ
RUDDER 1/16 RIBS
AREA 65.5
RUDDER
9 3/4
PIN THRU 3/32 SHAFT
CERAMI FREE O
BAMBOO SPAR IN RUDDER - CEMENT BACK OF END POST
1/32 SHEET
BIND
GEAR BOX
6 1/4
19 1/4
2 3/4
1/8 SQ
1/8 x 1/4
3/32 x 5/32
1/8 x 5/16
STAB - FLAT CLARK Y 1/16 RIBS
#50
9" TREAD
1/16
GEAR ASSEM. SHOWN IN POWER CHAPTER
ADJUST WITH RUDDER BY FORCING L.E. OFF AND RECEMENTING
18 x 2 x 1 1/2
POWER
18-20 STR. 1/8 BROWN
4" SLACK - EACH MOTOR
TIME
WAKEFIELD - 70.08 AVE.
ONLY ONE 210s - FLIGHT - 'S' HOOK CRACKED SHAFT
2" DIA TURNED BALSA
2 1/4
A 1937 CANADIAN WAKEFIELD ENTRY by J.E. ADAMS OTTOWA, CANADA

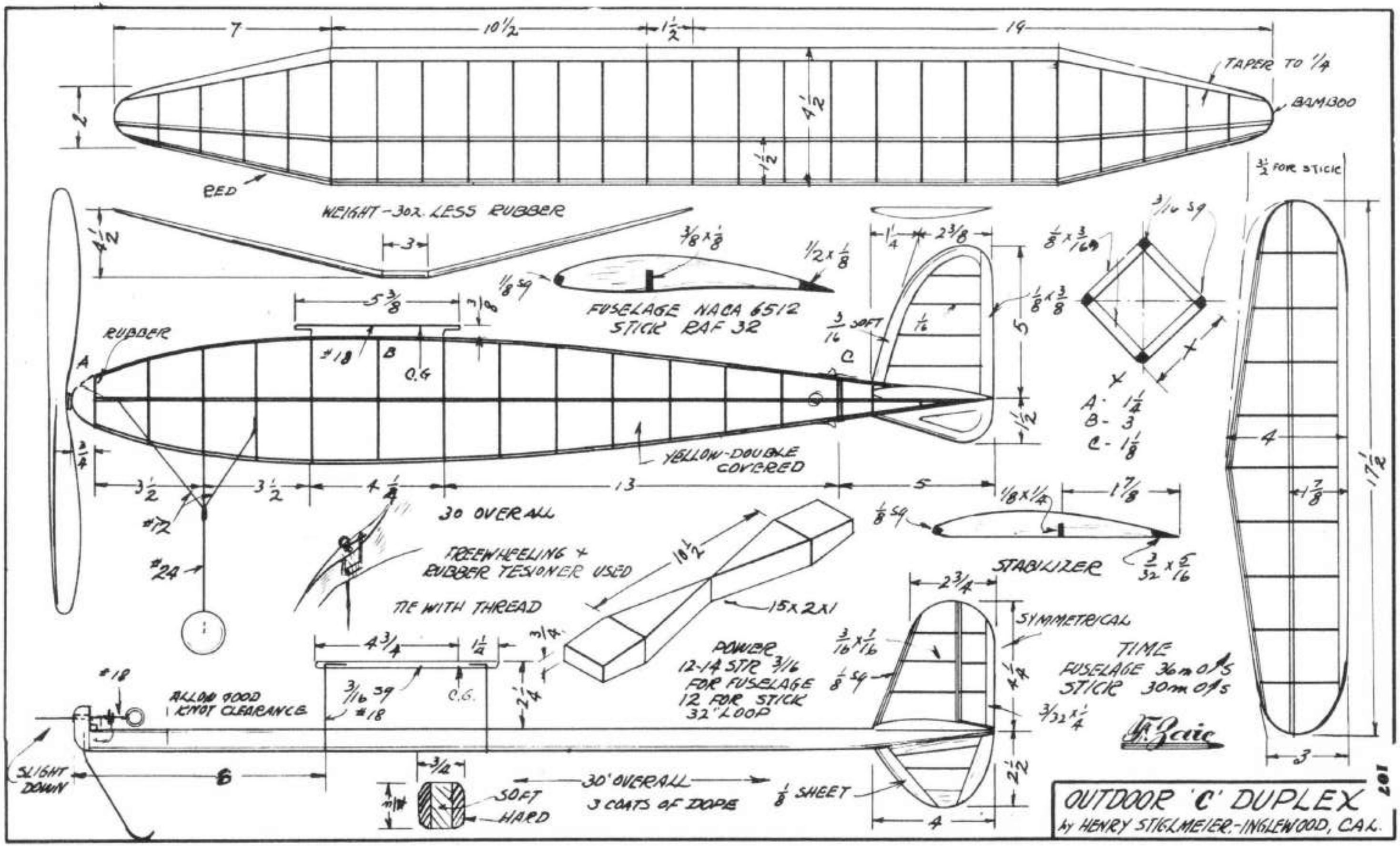

1937 SWEDISH WAKEFIELD
DESIGNED by BJORN ANDERSON
FLOWN BY
B. ANDERSON 6th PLACE 155.73.
G. STARK 8th PLACE 151.83.
PROP - 18" DIA 23½" PITCH
POWER - 16 STRANDS - ¼ BROWN
FUSELAGE LENGTH 1050MM
WING SPAN 1160 MM. C-120MM
DIMENSIONS GIVEN WERE TAKEN
FROM SCALE DRAWNING +- VARIATIONS
CLARK Y (C=120 m.m)
1/20
1/8 x 3/8
3/16 x 5/8
1/8 sq (3x3
1/8 x 3/16 (3x5)
TUBES
2¼ DIA.
103

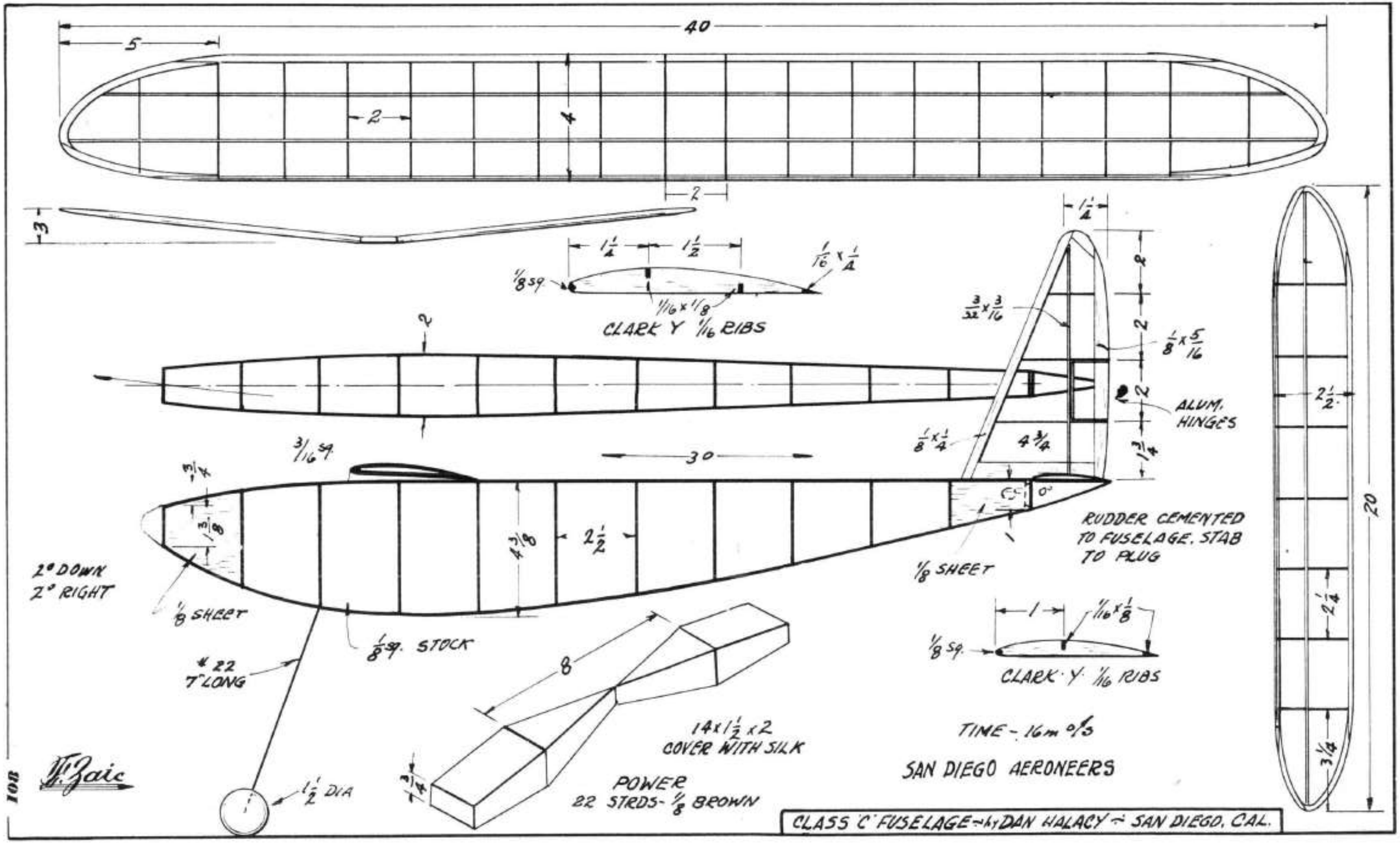

1/32 SHEET
GÖTT 497 1/32 RIBS
CLARK Y 1/32 RIBS
NOSE BLOCK 1/8 LAM. BALSA
1/32 SHEET WING FAIRING FOR EXTRA CROSS SECTION
SYM. 1/32 RIBS
1/16 SHEET
SLIGHT DOWN
8" TREAD
2 DIA.
POWER 10 STR. 1/4 BROWN
MODEL STEADY - ONLY TROUBLE RUBBER BUNCHING IN GLIDE
WT. 9oz. ~ TIME 50m. 45s
MEETS N.A.A., WAKEFIELD & FAI RULES
by BOB CHATELAIN FINDLAY, OHIO.

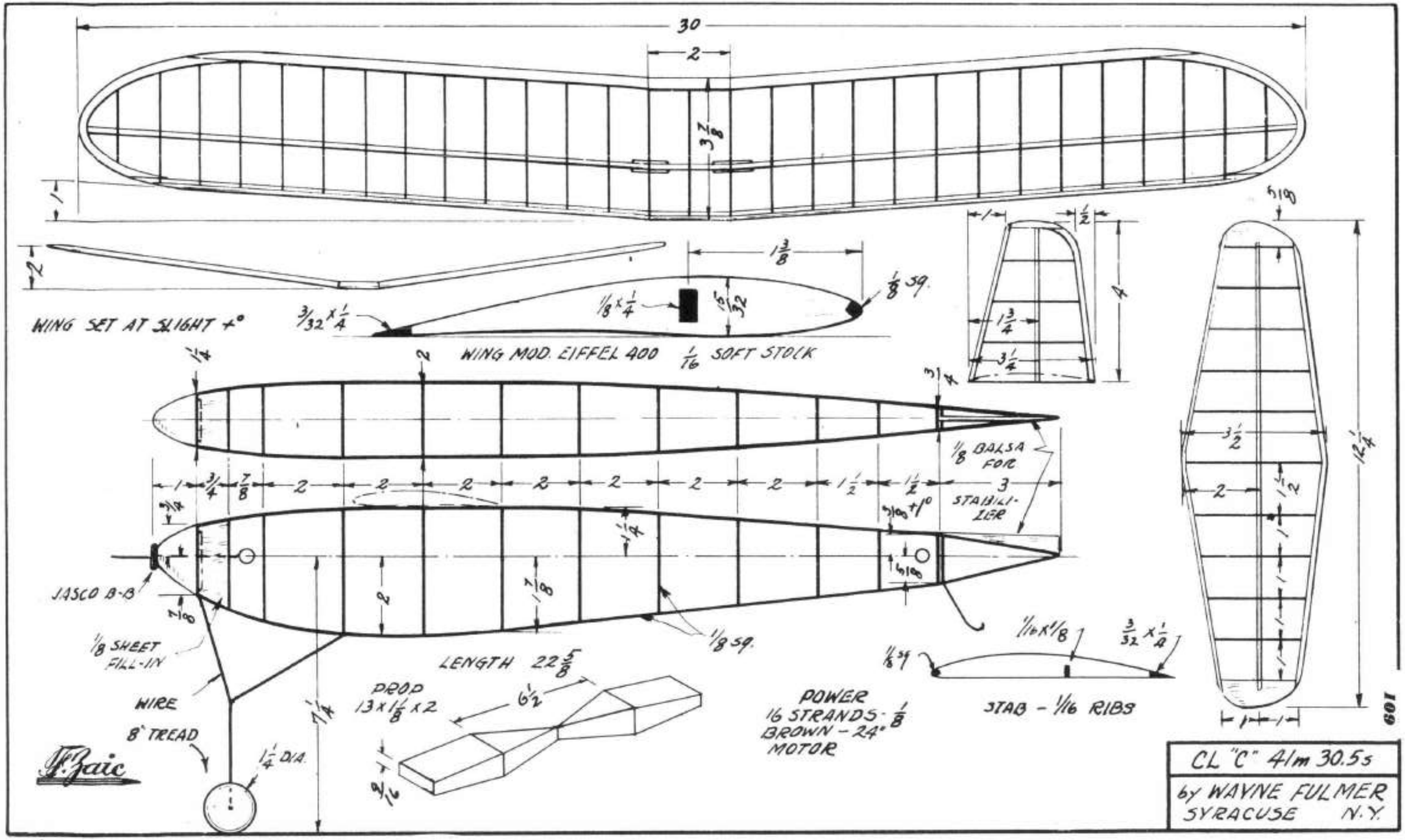


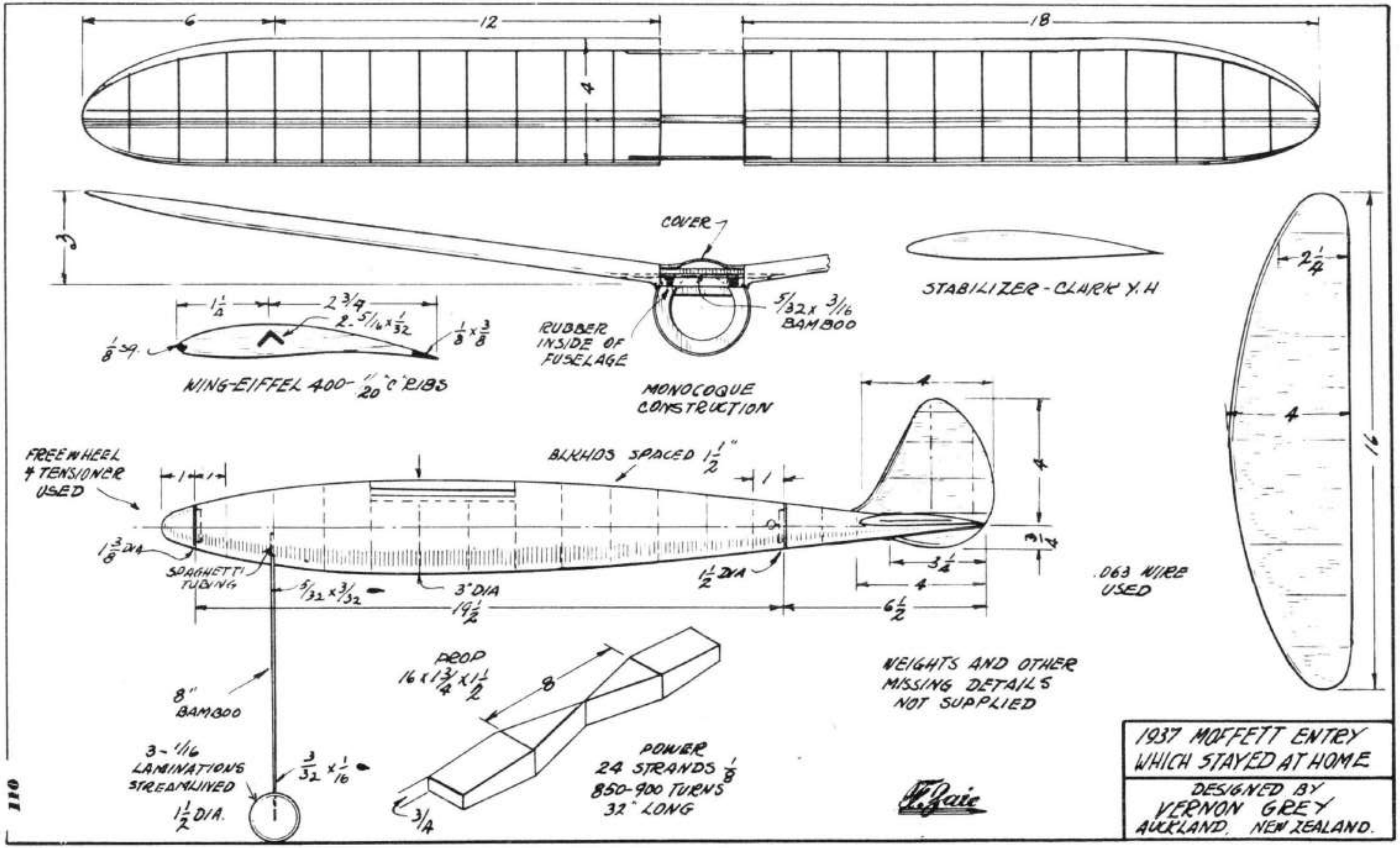
WING .44
STAB .10
RUDD. .05
FUSEL .88
PROPS .20
ACCES. .08
1.75
RUBB 1.30
3.05 OZ
BAMBOO
STAB-CLARK Y
WIRE EYES
NACA 6409
CELLOPHANE
SYMMETRICAL
WIRE EYES
BAMBOO MOUNT
WINDING PLUG
1½° DOWN
2½° UP
8½ TREAD
WASHER SOL.
15×1×1½ MAKE RIGHT & LEFT
POWER - 2 MOTORS
10 STRS 29½ LONG 1/8 BROWN
CLARK Y
F. Zaic
PUSH-PULL FUSELAGE by Norman C. Schaller - PHILA. PA.


CHICAGO AERONUTS
WING .67
TAIL AS. .48
PROP .54
FUSEL 1.35
RUBBER 1.64
REMOVABLE COVER FIXED AFTER ADJUSTS
CLARK Y TOP
CUT RIBS 1/8 x 1/16
1/16 SQ.
1/16 SHEET
2° RIGHT
2° DOWN
1/32 SHEET OUTLINE
CLARK Y
1/8 SQ
CEMENT RIBS FIRST THEN L.E.
1/16 x 1/8 CUT RIBS
COVER TOP & BOTTOM
TO HOLD TAIL ON STAB
ONE PIECE STAB
4-RUBBER HOOKS
1/4 INC
40" STICK 3/4 x 1/2 x 3/8
SAME CONST.
WIRE
1/8 x 1/32 CAPS
STAB MADE IN TWO PIECES CEMENT TO SIDES
FIX TUBES TO EXTRA BRACES AFTER SIDES ARE CEMENTED
CRINK WIRE TO ASSURE TIGHT FIT REMOVE FOR FOLD BACK
1/16 DIA
1 3/4 DIA
16 x 2 x 1 3/4
POWER
16 STR. 1/4 BROWN
FUSELAGE CONSTRUCTION
SEE PAGE 60 IN 1937 Y. BOOK FOR DETAILS
2° DOWN
2° RIGHT
THE HEXAGON — by John Kubilis Jr. CHICAGO, ILL.

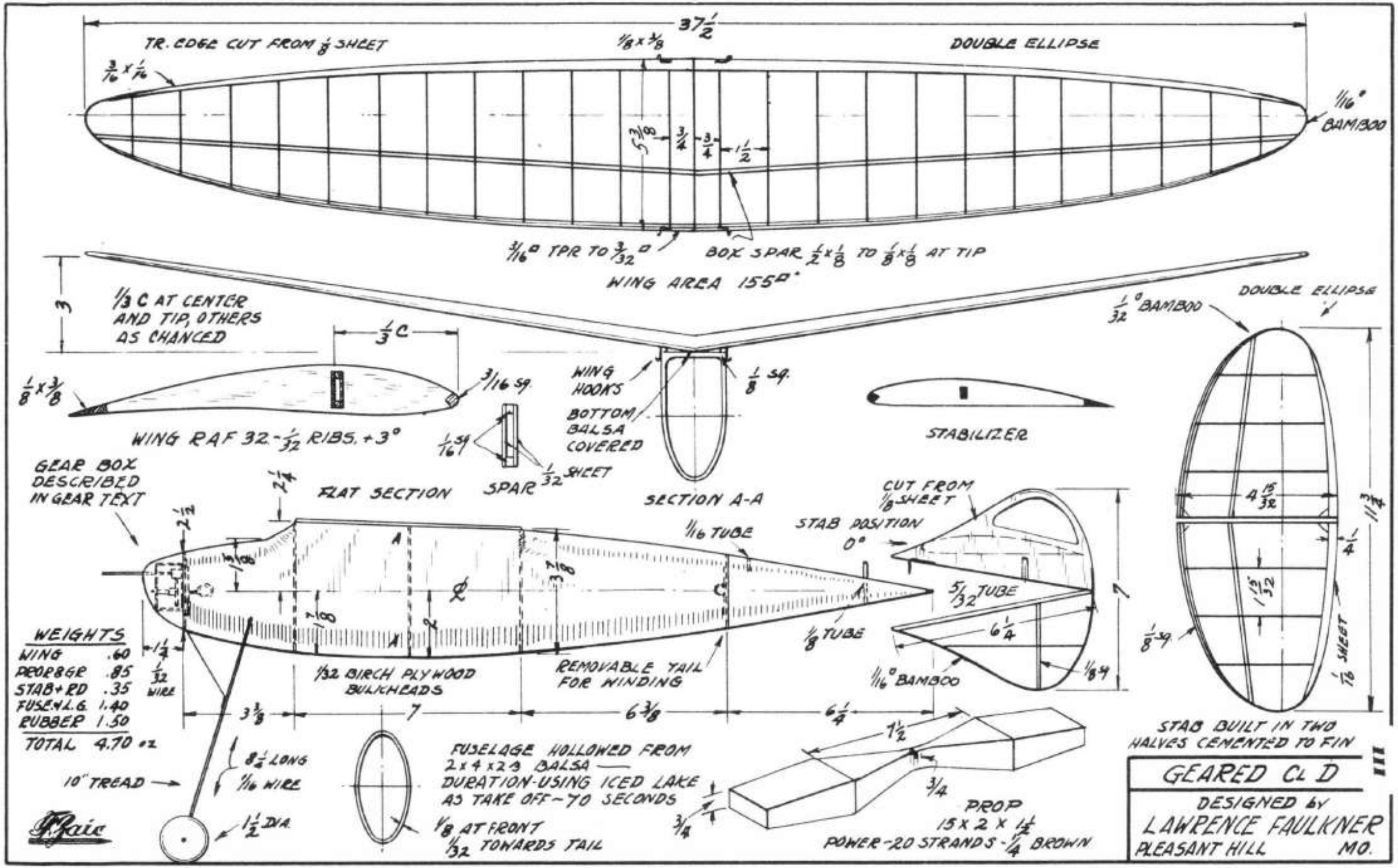

OUTDOOR 'C' DUPLEX
by HENRY STIGLMEIER - INGLEWOOD, CAL.
TAPER TO 1/4
BAMBOO
RED
WEIGHT - 3 OZ. LESS RUBBER
FUSELAGE NACA 6512
STICK RAF 32
YELLOW-DOUBLE COVERED
30 OVERALL
FREEWHEELING + RUBBER TESIONER USED
TIE WITH THREAD
RUBBER
15 X 2 X 1
POWER
12-14 STR 3/16
FOR FUSELAGE
12 FOR STICK
32" LOOP
STABILIZER
SYMMETRICAL
TIME
FUSELAGE 36 m 0 s
STICK 30 m 0 s
A - 1 1/4
B - 3
C - 1 1/8
3 1/2 FOR STICK
ALLOW GOOD KNOT CLEARANCE
SLIGHT DOWN
30" OVERALL
3 COATS OF DOPE
1/8 SHEET
SOFT
HARD

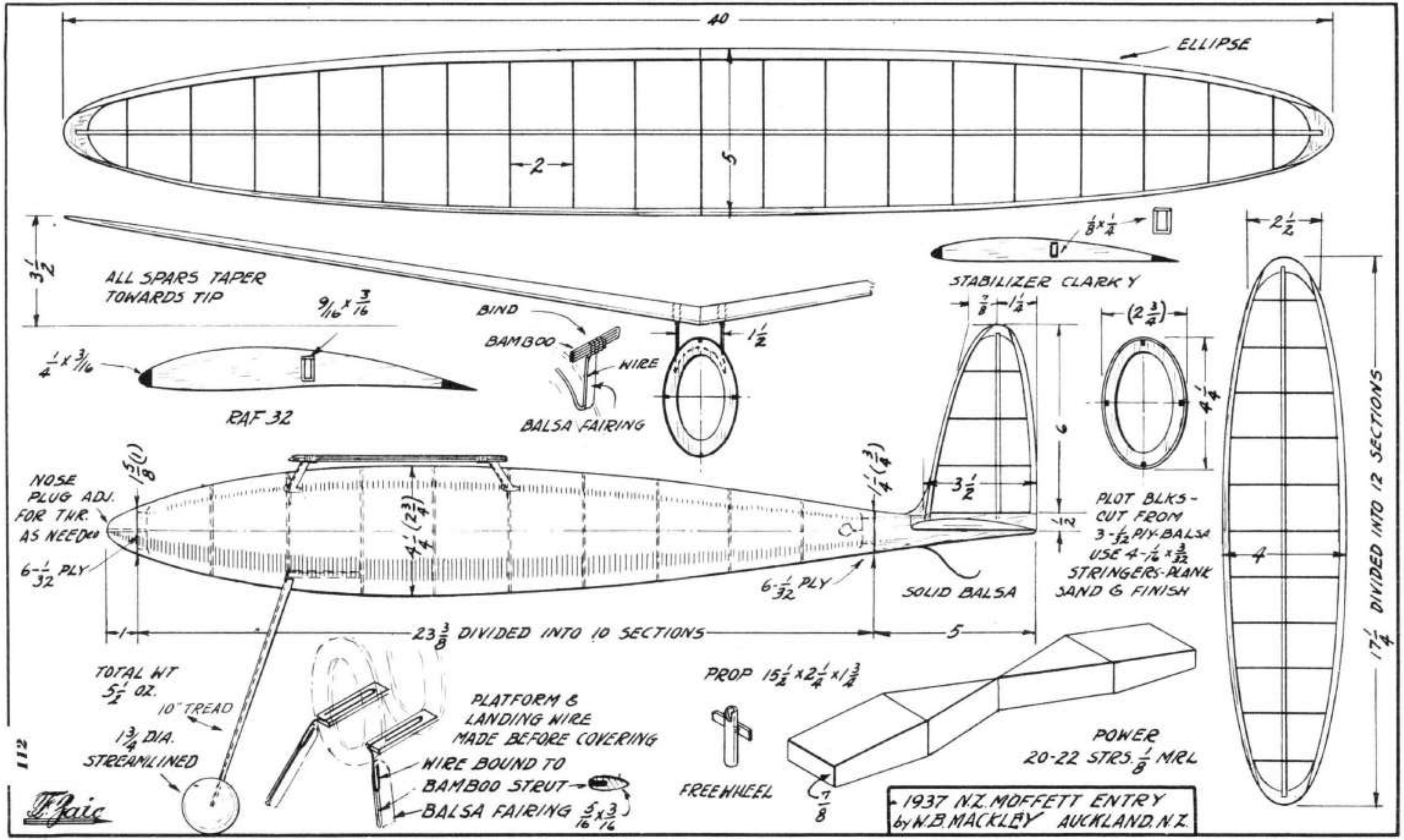

40
5
2
4
2
3
1 1/4
1 1/2
1/8 sq.
1/16 x 1/4
1/16 x 1/8
CLARK Y 1/16 RIBS
2
3/16 sq.
30
3/4
1 3/8
4 3/8
2 1/2
2° DOWN
2° RIGHT
1/8 SHEET
1/8 sq. STOCK
22
7" LONG
1 1/2 DIA
8
3/4
14 x 1 1/2 x 2
COVER WITH SILK
POWER
22 STRDS- 1/8 BROWN
1 1/4
3/32 x 3/16
1/8 x 5/16
ALUM. HINGES
1/8 x 1/4
4 3/4
1 3/4
RUDDER CEMENTED TO FUSELAGE. STAB TO PLUG
1/8 SHEET
1
1/8 sq.
1/16 x 1/8
CLARK Y 1/16 RIBS
TIME - 16m o/s
SAN DIEGO AERONEERS
2 1/2
2 1/4
3 1/4
20
CLASS 'C' FUSELAGE - by DAN HALACY - SAN DIEGO, CAL.


WING SET AT SLIGHT +°
WING MOD. EIFFEL 400
1/16 SOFT STOCK
1/8 SQ.
1/8 x 1/4
3/32 x 1/4
1/8 BALSA FOR STABILIZER
JASCO B-B
1/8 SHEET FILL-IN
WIRE
8" TREAD
1 1/4 DIA.
LENGTH 22 5/8
PROP 13 x 1 1/8 x 2
POWER
16 STRANDS 1/8
BROWN - 24" MOTOR
STAB - 1/16 RIBS
1/16 x 1/8
3/32 x 1/4
CL "C" A/m 30.5s
by WAYNE FULMER
SYRACUSE N.Y.

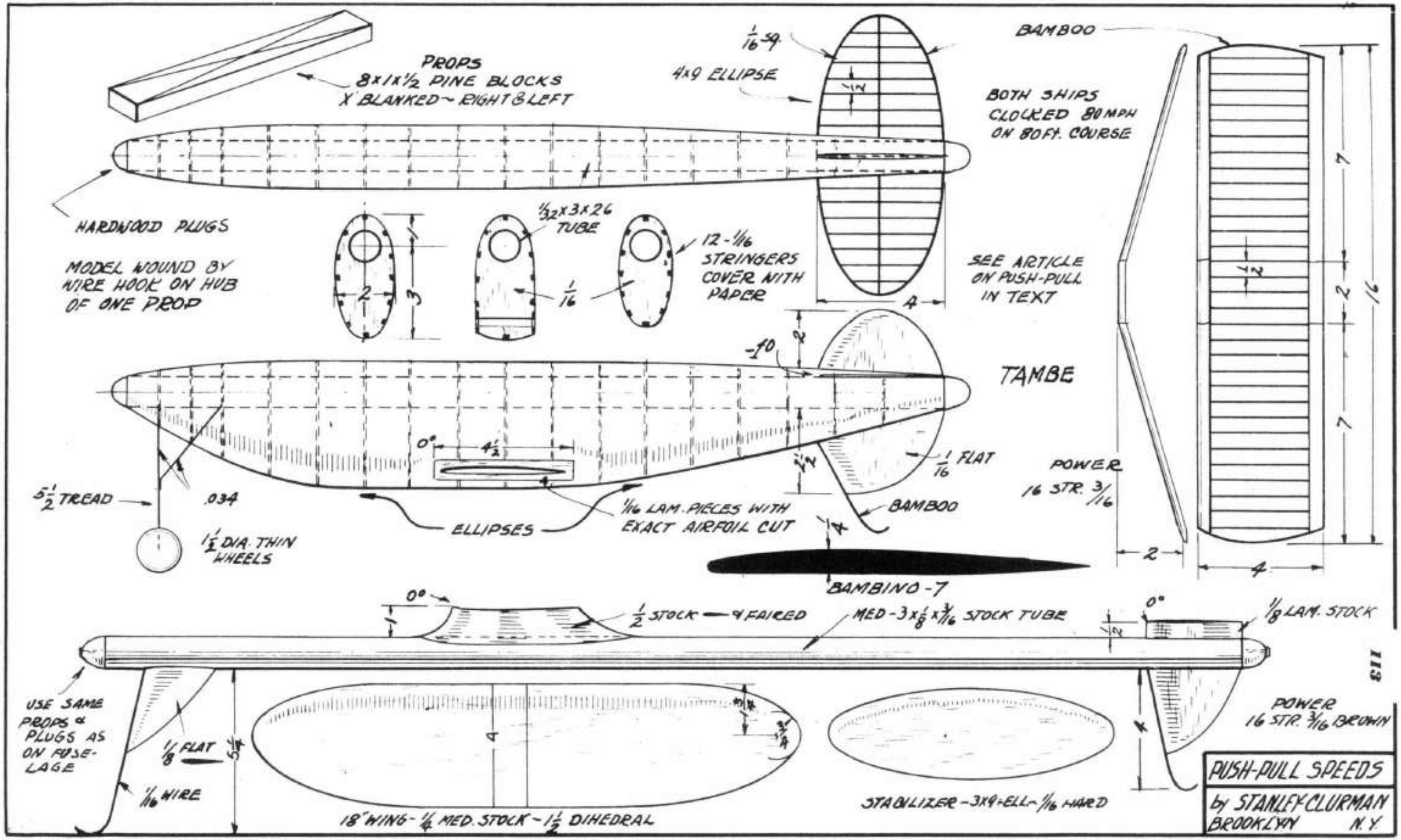


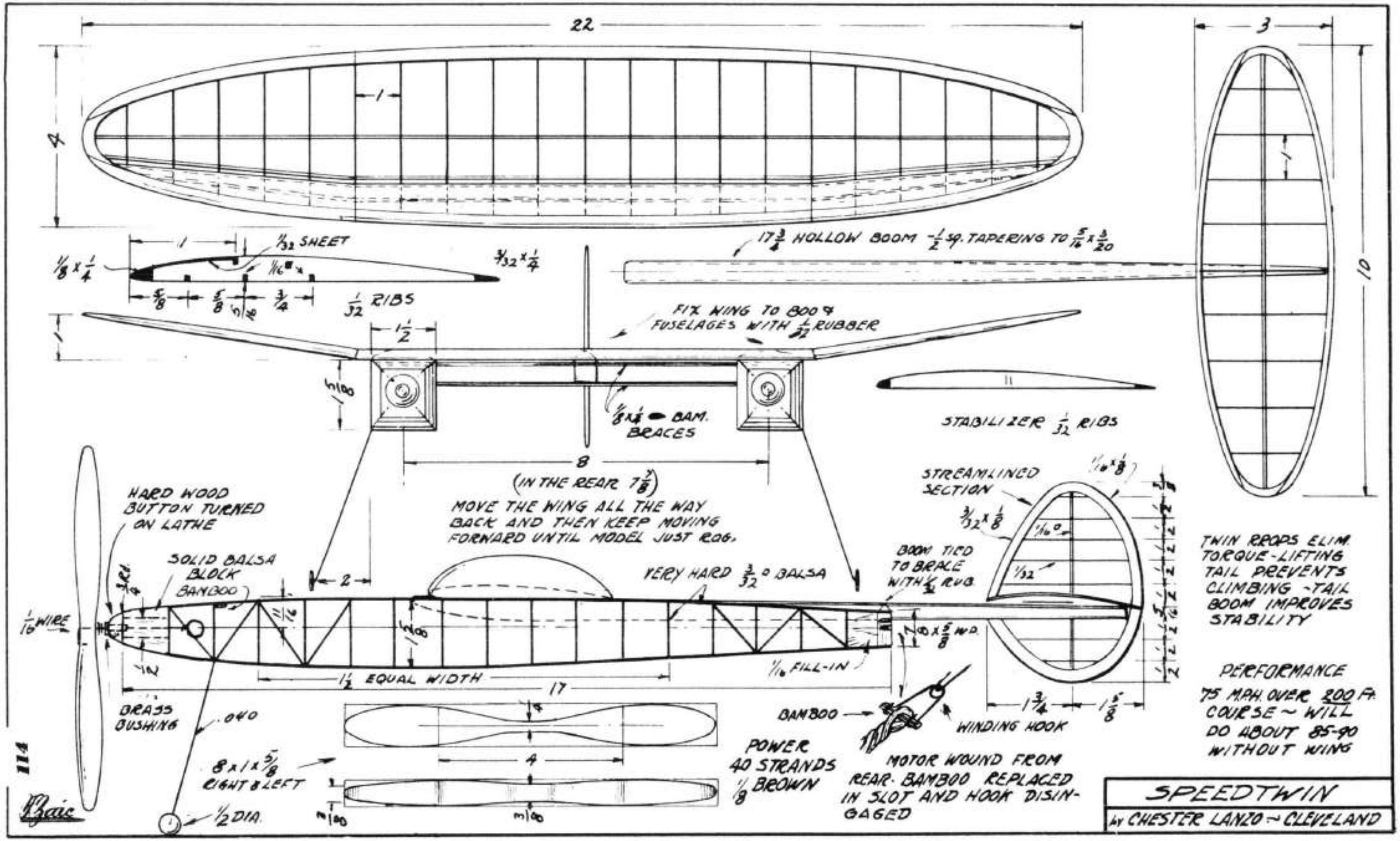
1937 MOFFETT ENTRY
WHICH STAYED AT HOME
DESIGNED BY
VERNON GREY
AUCKLAND, NEW ZEALAND.
WING-EIFFEL 400- 1/20" "C" RIBS
STABILIZER - CLARK Y. H
COVER
RUBBER INSIDE OF FUSELAGE
5/32 x 3/16 BAMBOO
MONOCOQUE CONSTRUCTION
BLKHDS SPACED 1 1/2"
FREEWHEEL & TENSIONER USED
SPAGHETTI TUBING
1 3/8 DIA
3" DIA
1 1/2 DIA
.063 WIRE USED
8" BAMBOO
3 - 1/16 LAMINATIONS STREAMLINED
1 1/2 DIA.
PROP 16 x 1 3/4 x 1 1/2
POWER
24 STRANDS 1/8
850-900 TURNS
32" LONG
WEIGHTS AND OTHER
MISSING DETAILS
NOT SUPPLIED


37 1/2
TR. EDGE CUT FROM 1/8 SHEET
3/16 x 1/16
1/8 x 3/8
DOUBLE ELLIPSE
1/16° BAMBOO
5 3/8
3/4
3/4
1 1/2
3/16° TPR TO 3/32°
BOX SPAR 1/2 x 1/8 TO 1/8 x 1/8 AT TIP
WING AREA 155°"
3
1/3 C AT CENTER AND TIP, OTHERS AS CHANGED
1/3 C
1/8 x 3/8
3/16 SQ.
WING RAF 32 - 1/32 RIBS, +3°
1/16 SQ
1/32 SHEET
SPAR
WING HOOKS
BOTTOM BALSA COVERED
1/8 SQ.
SECTION A-A
STABILIZER
1/32° BAMBOO
DOUBLE ELLIPSE
GEAR BOX DESCRIBED IN GEAR TEXT
2 1/4
FLAT SECTION
2 1/2
1/16 TUBE
CUT FROM 1/8 SHEET
STAB POSITION 0°
5/32 TUBE
1/8 TUBE
6 1/4
7
1/16° BAMBOO
1/8 SQ
4 15/32
11 3/4
1/4
1 15/32
1/8 SQ
1/16 SHEET
WEIGHTS
WING .60
PROP&GR .85
STAB+RD .35
FUSE+LG 1.40
RUBBER 1.50
TOTAL 4.70 oz
1 1/4
1/32 WIRE
1/32 BIRCH PLYWOOD BULKHEADS
REMOVABLE TAIL FOR WINDING
3 3/8
7
6 3/8
6 1/4
8 1/4 LONG 1/16 WIRE
10" TREAD
1 1/2 DIA.
FUSELAGE HOLLOWED FROM 2 x 4 x 23 BALSA — DURATION-USING ICED LAKE AS TAKE OFF — 70 SECONDS
1/8 AT FRONT
1/32 TOWARDS TAIL
1 1/2
3/4
PROP 15 x 2 x 1 1/2
POWER - 20 STRANDS - 1/4 BROWN
STAB BUILT IN TWO HALVES CEMENTED TO FIN
GEARED CL D
DESIGNED BY LAWRENCE FAULKNER
PLEASANT HILL MO.
111

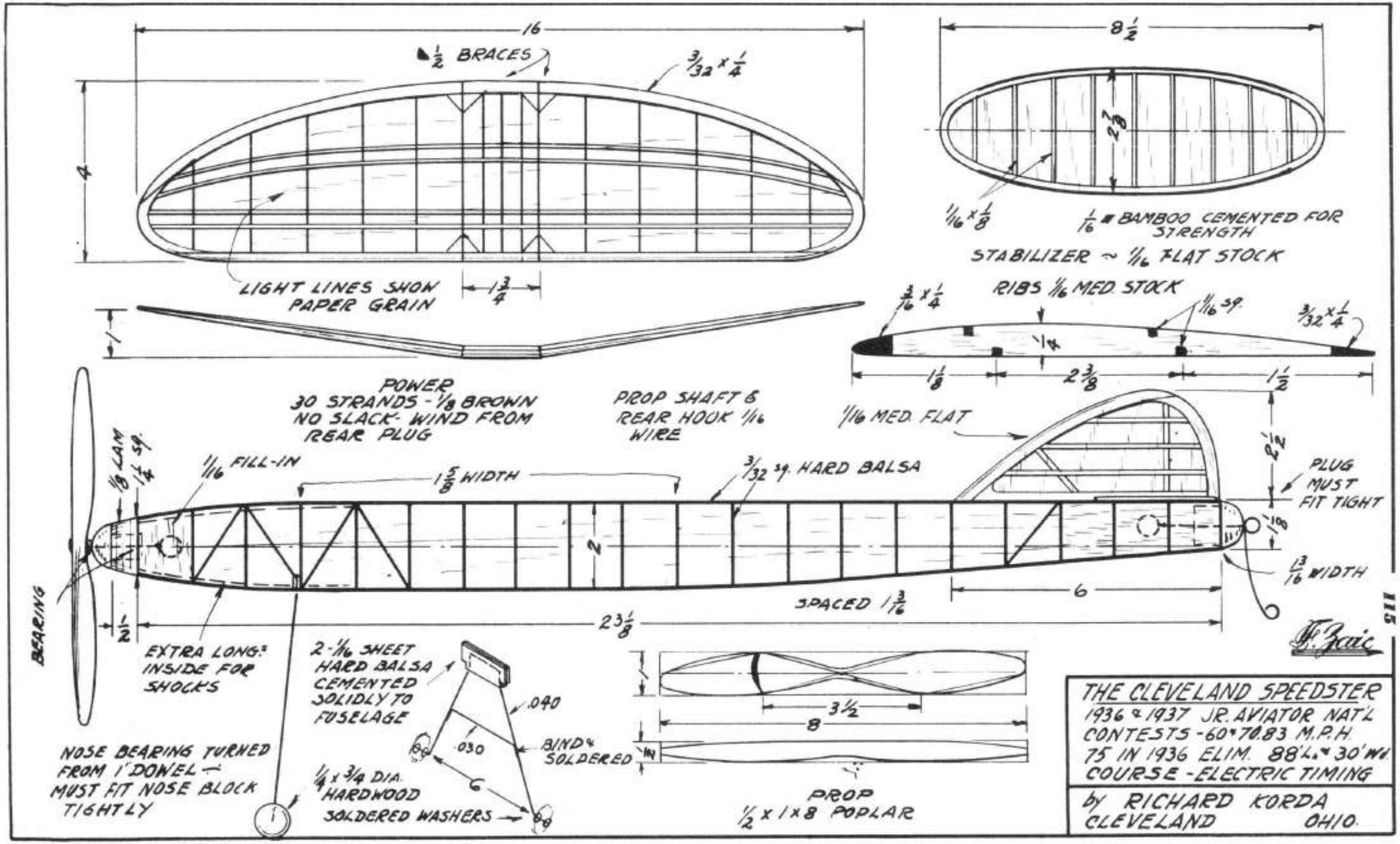


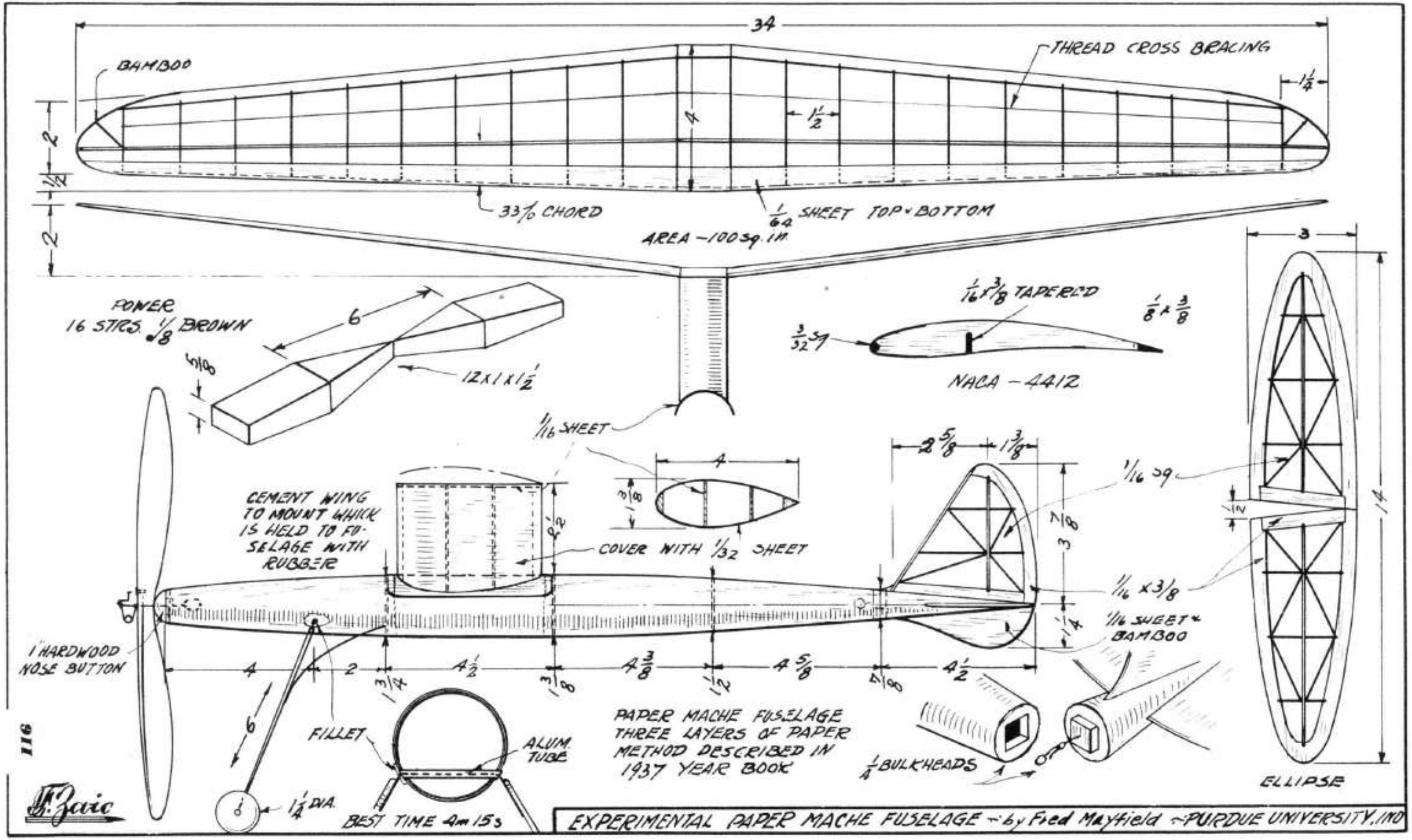
40
ELLIPSE
2
5
3 1/2
ALL SPARS TAPER TOWARDS TIP
9/16 x 3/16
1/4 x 3/16
RAF 32
BIND
BAMBOO
WIRE
BALSA FAIRING
1 1/2
1/8 x 1/4
STABILIZER CLARK Y
7/8
1/4
2 1/2
(2 3/4)
4 1/4
6
3 1/2
1/2
NOSE PLUG ADJ. FOR THR. AS NEED'D
1 5/8 (1)
4 1/4 (2 3/4)
1 1/4 (3/4)
6-1/32 PLY
6-1/32 PLY
SOLID BALSA
PLOT BLKS-CUT FROM 3-1/32 PLY-BALSA USE 4-1/16 x 3/32 STRINGERS-PLANK SAND & FINISH
4
17 1/4 DIVIDED INTO 12 SECTIONS
1
23 3/8 DIVIDED INTO 10 SECTIONS
5
TOTAL WT 5 1/2 OZ.
10" TREAD
1 3/4 DIA. STREAMLINED
PLATFORM & LANDING WIRE MADE BEFORE COVERING
WIRE BOUND TO BAMBOO STRUT
BALSA FAIRING 5/16 x 3/16
PROP 15 1/2 x 2 1/4 x 1 3/4
FREEWHEEL
7/8
POWER 20-22 STRS. 1/8 MRL
1937 N.Z. MOFFETT ENTRY
by W.B. MACKLEY AUCKLAND N.Z.
112


PROPS
8x1x½ PINE BLOCKS
X BLANKED ~ RIGHT & LEFT
HARDWOOD PLUGS
MODEL WOUND BY WIRE HOOK ON HUB OF ONE PROP
1/32x3x26 TUBE
12-1/16 STRINGERS COVER WITH PAPER
1/16 SQ.
4x9 ELLIPSE
BAMBOO
BOTH SHIPS CLOCKED 80 MPH ON 80 FT. COURSE
SEE ARTICLE ON PUSH-PULL IN TEXT
TAMBE
POWER 16 STR. 3/16
1/16 FLAT
BAMBOO
5½ TREAD
.034
1½ DIA. THIN WHEELS
ELLIPSES
1/16 LAM. PIECES WITH EXACT AIRFOIL CUT
BAMBINO-7
½ STOCK — & FAIRED
MED-3x⅛x3/16 STOCK TUBE
⅛ LAM. STOCK
USE SAME PROPS & PLUGS AS ON FUSELAGE
⅛ FLAT
1/16 WIRE
18" WING - ¼ MED. STOCK - 1½ DIHEDRAL
STABILIZER - 3x9-ELL - 1/16 HARD
POWER 16 STR. 3/16 BROWN
PUSH-PULL SPEEDS
by STANLEY CLURMAN
BROOKLYN N.Y.

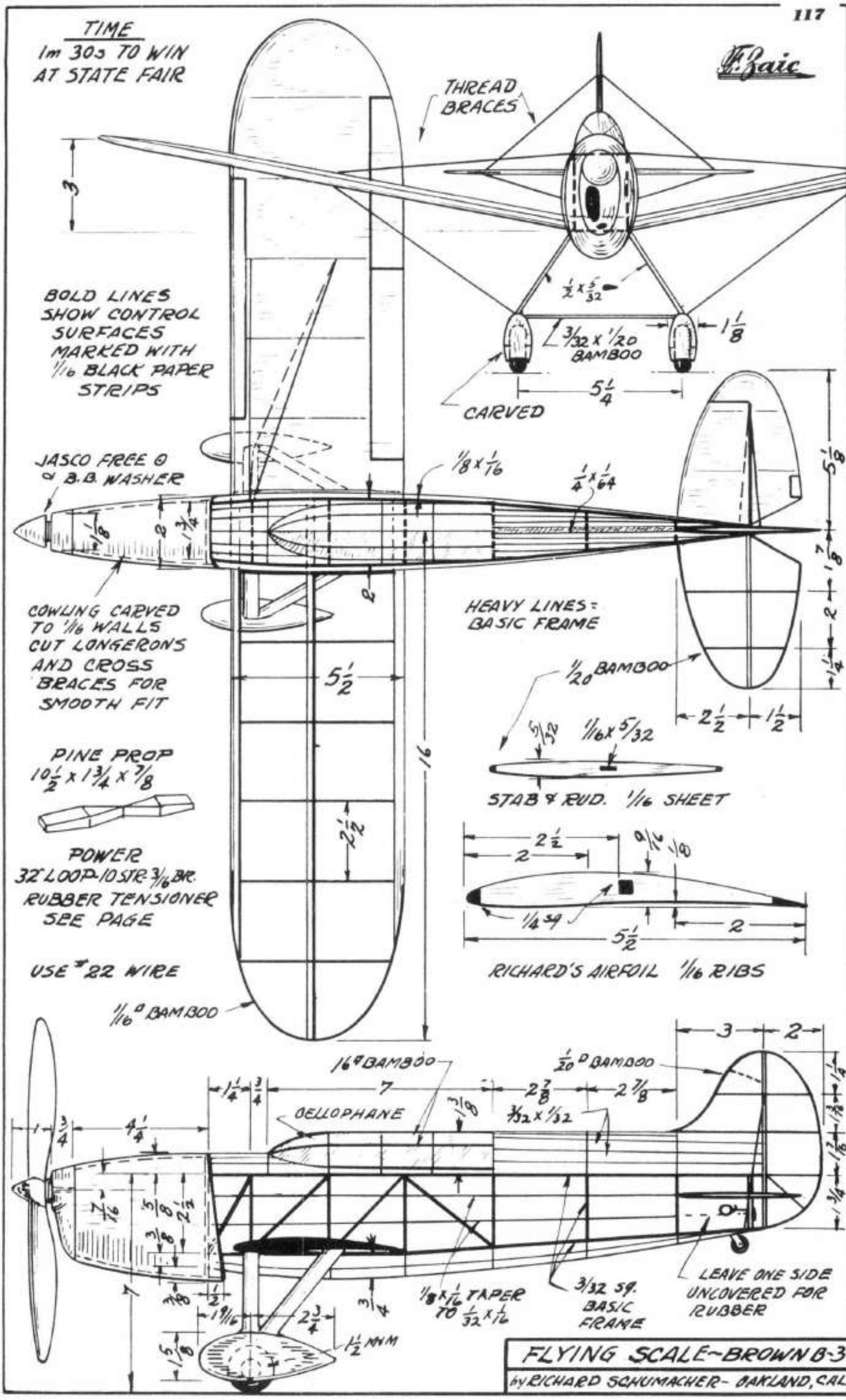


22
4
1
1/32 SHEET
1/8 x 1/4
1/16" x
3/32 x 1/4
5/8
5/8
5/16
3/4
1/32 RIBS
1
1 1/2
5/16
FIX WING TO BOO & FUSELAGES WITH 1/32 RUBBER
1/8 x 1/4 BAM. BRACES
17 3/4 HOLLOW BOOM 1/2 SQ. TAPERING TO 5/16 x 3/20
3
10
STABILIZER 1/32 RIBS
8
(IN THE REAR 7 7/8)
MOVE THE WING ALL THE WAY BACK AND THEN KEEP MOVING FORWARD UNTIL MODEL JUST ROG.
HARD WOOD BUTTON TURNED ON LATHE
SOLID BALSA BLOCK
BAMBOO
1/16 WIRE
2
11/16
1 5/8
VERY HARD 3/32 BALSA
1/16 FILL-IN
1 1/2 EQUAL WIDTH
17
BRASS BUSHING
.040
8 x 1 x 5/8 RIGHT & LEFT
1/2 DIA.
4
POWER 40 STRANDS 1/8 BROWN
BOOM TIED TO BRACE WITH 1/32 RUB.
STREAMLINED SECTION
3/32 x 1/8
1/16 x 1/8
1/32
BAMBOO
WINDING HOOK
MOTOR WOUND FROM REAR. BAMBOO REPLACED IN SLOT AND HOOK DISINGAGED
1 3/4
1 5/8
TWIN PROPS ELIM. TORQUE-LIFTING TAIL PREVENTS CLIMBING - TAIL BOOM IMPROVES STABILITY
PERFORMANCE
75 M.P.H. OVER 200 FT. COURSE ~ WILL DO ABOUT 85-90 WITHOUT WING
SPEEDTWIN
by CHESTER LANZO ~ CLEVELAND
114


16
1/2 BRACES
3/32 x 1/4
4
LIGHT LINES SHOW PAPER GRAIN
1 3/4
1
8 1/2
2 7/8
1/16 x 1/8
1/16 BAMBOO CEMENTED FOR STRENGTH
STABILIZER ~ 1/16 FLAT STOCK
RIBS 1/16 MED. STOCK
3/16 x 1/4
1/16 SQ.
3/32 x 1/4
1/4
1 1/8
2 3/8
1 1/2
POWER
30 STRANDS - 1/8 BROWN
NO SLACK- WIND FROM
REAR PLUG
PROP SHAFT & REAR HOOK 1/16 WIRE
1/16 MED. FLAT
2 1/2
PLUG MUST FIT TIGHT
1/8 LAM 1/4 SQ.
1/16 FILL-IN
1 5/8 WIDTH
3/32 SQ. HARD BALSA
2
1 1/8
13/16 WIDTH
6
SPACED 1 3/16
BEARING
1/2
23 1/8
EXTRA LONG'S INSIDE FOR SHOCKS
2 - 1/16 SHEET HARD BALSA CEMENTED SOLIDLY TO FUSELAGE
.040
.030
BIND & SOLDERED
6
1/4 x 3/4 DIA. HARDWOOD
SOLDERED WASHERS
NOSE BEARING TURNED FROM 1" DOWEL - MUST FIT NOSE BLOCK TIGHTLY
1
3 1/2
8
1/4
PROP
1/2 x 1 x 8 POPLAR
THE CLEVELAND SPEEDSTER
1936 & 1937 JR. AVIATOR NAT'L
CONTESTS - 60 & 70.83 M.P.H.
75 IN 1936 ELIM. 88'L. & 30'WI.
COURSE - ELECTRIC TIMING
by RICHARD KORDA
CLEVELAND OHIO.

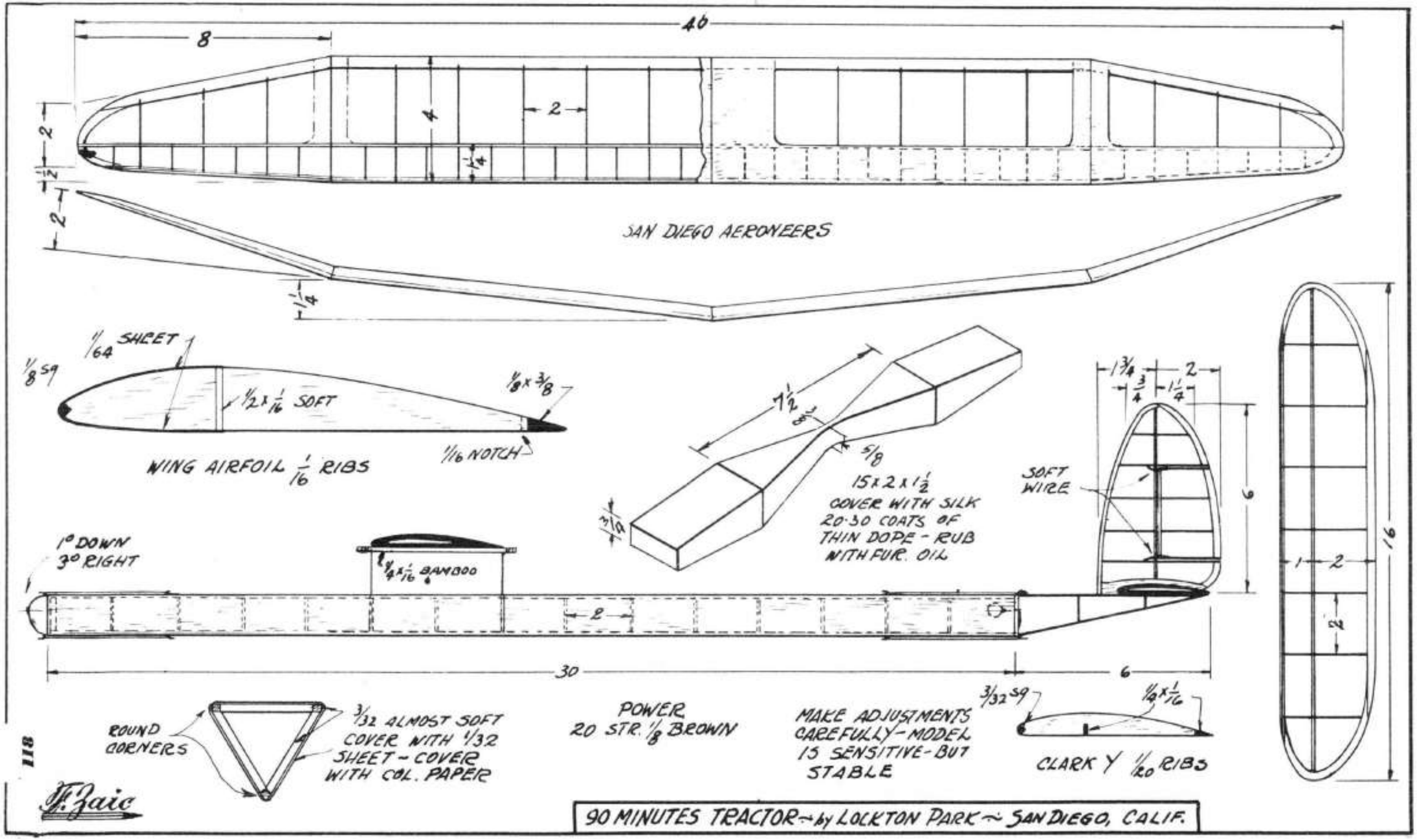


EXPERIMENTAL PAPER MACHE FUSELAGE — by Fred Mayfield — PURDUE UNIVERSITY, IND

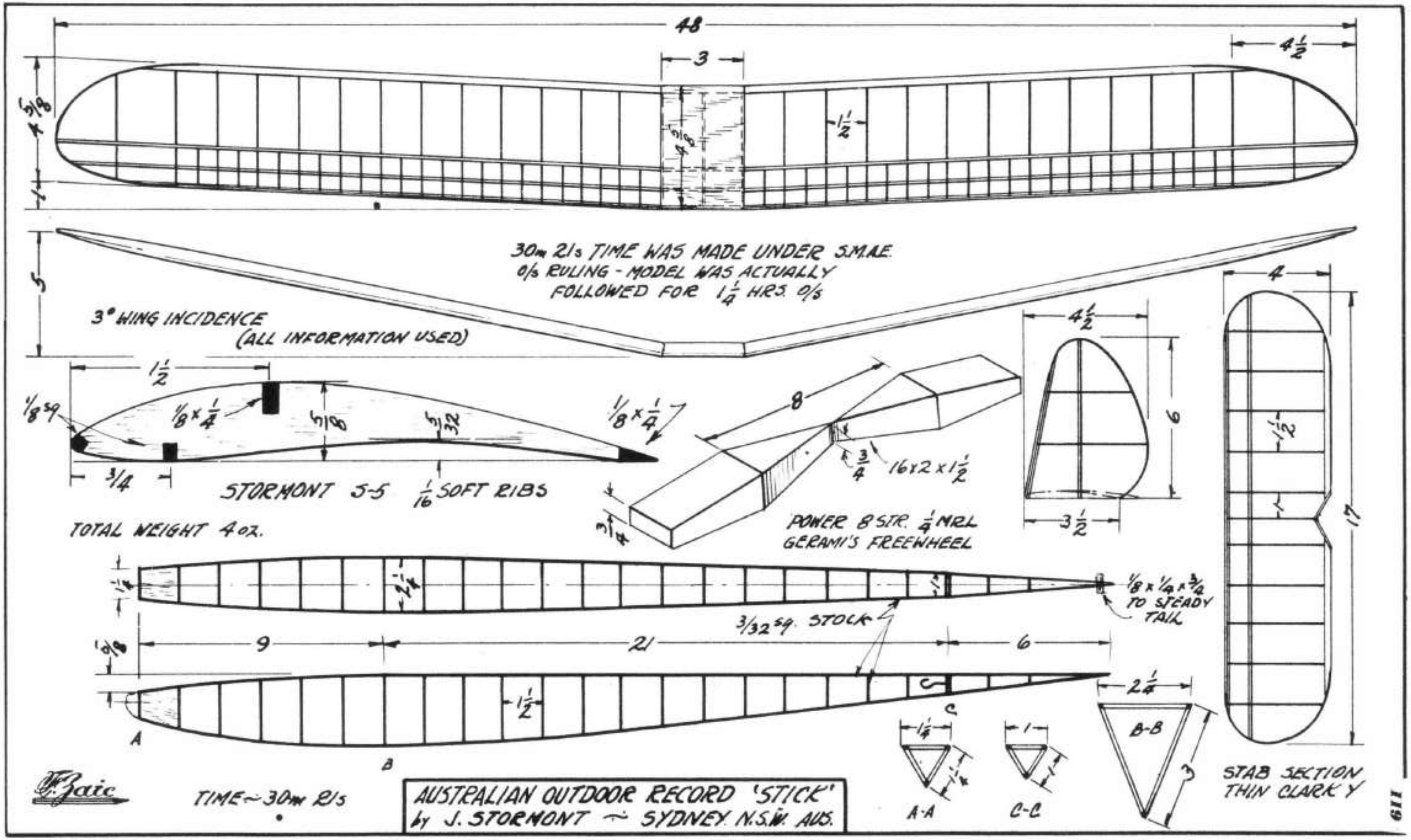


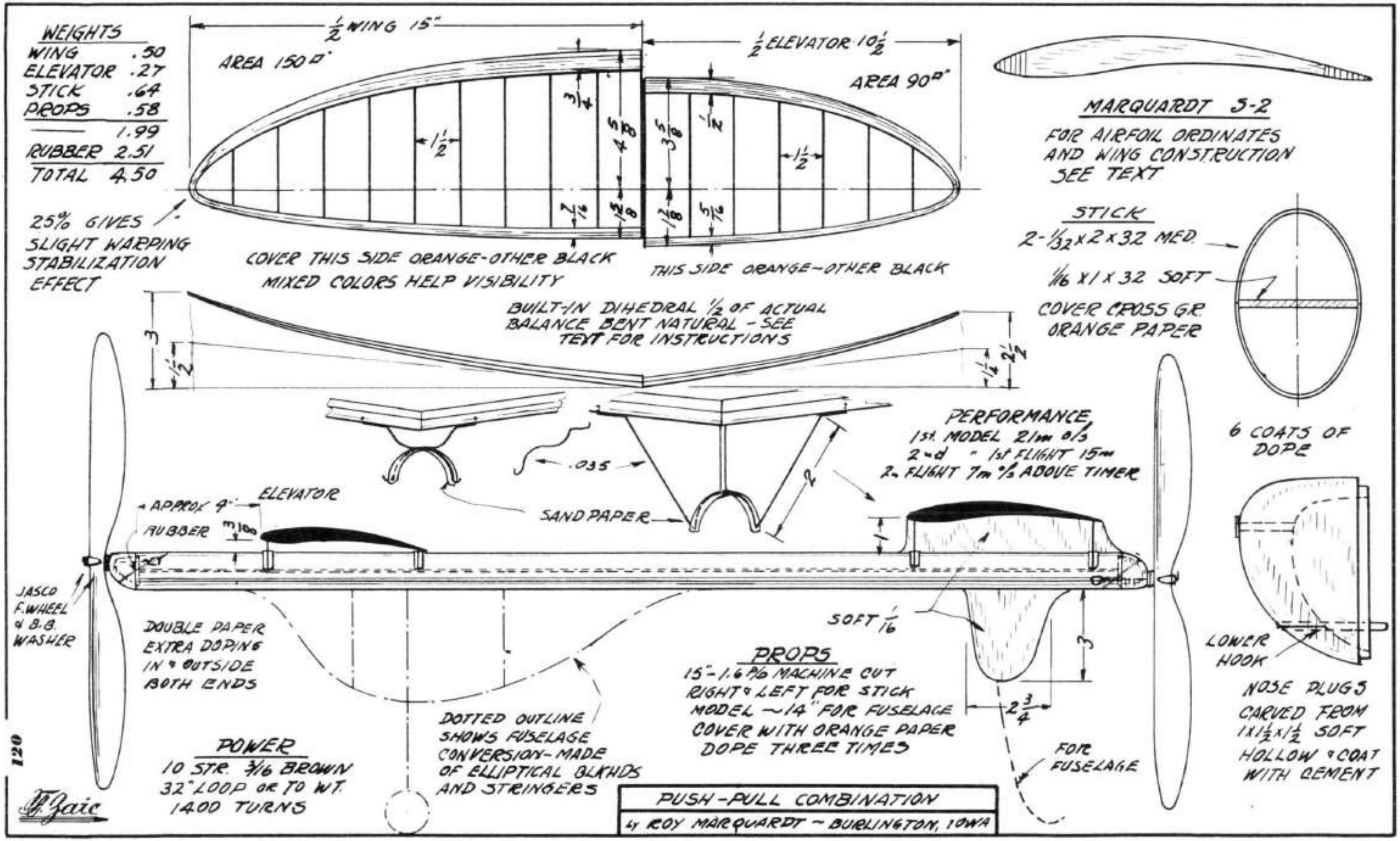
FLYING SCALE~BROWN B-3

by RICHARD SCHUMACHER- OAKLAND, CAL

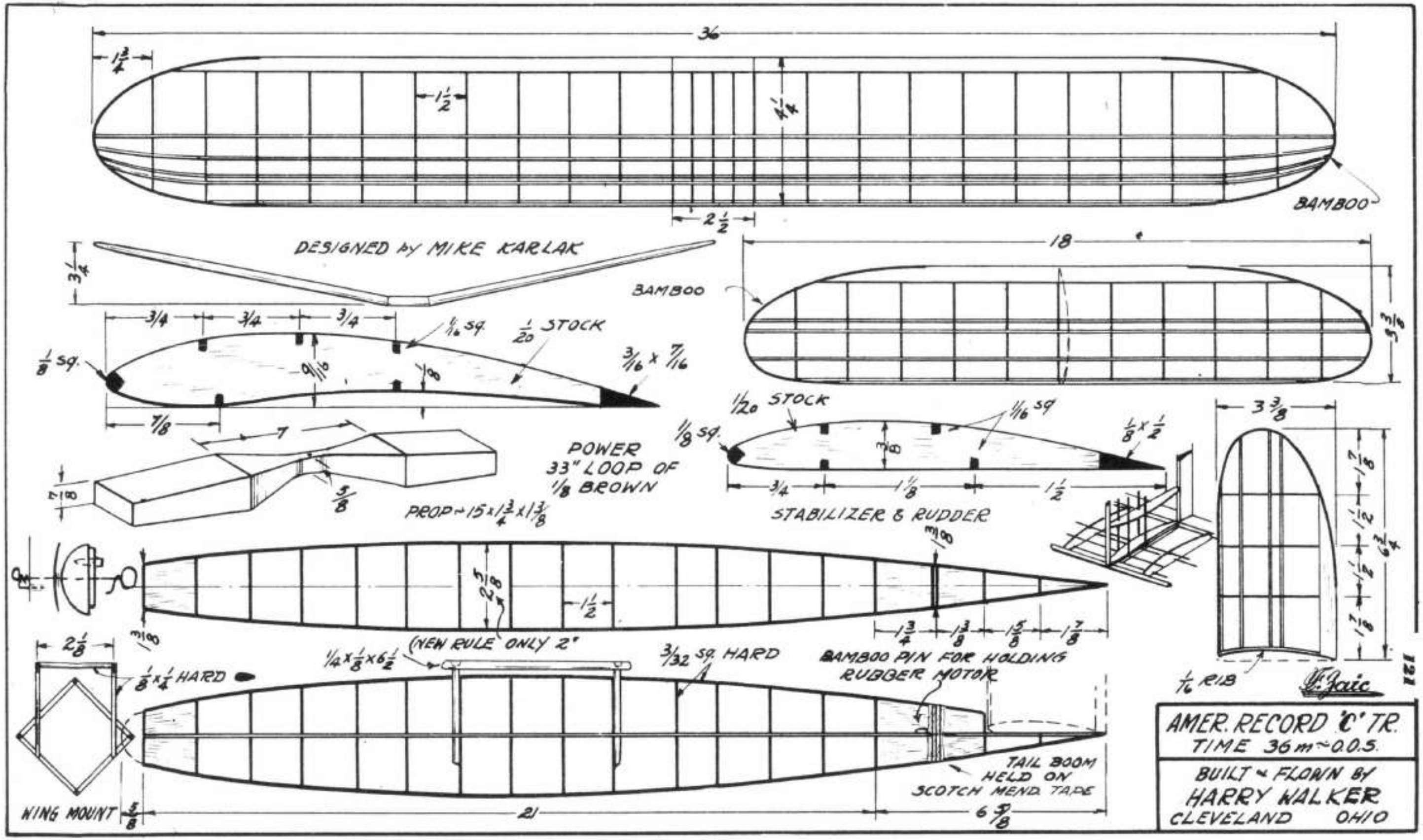


46
8
2
4
2
1/4
1/2
2
1 1/4
SAN DIEGO AERONEERS
1/64 SHEET
1/8 SQ
1/2 x 1/16 SOFT
1/8 x 3/8
1/16 NOTCH
WING AIRFOIL 1/16 RIBS
7 1/2
5/8
3/4
15 x 2 x 1 1/2
COVER WITH SILK
20-30 COATS OF
THIN DOPE - RUB
WITH FUR. OIL
1 3/4
2
3/4
1 1/4
SOFT
WIRE
6
16
1° DOWN
3° RIGHT
1/4 x 1/16 BAMBOO
2
30
6
ROUND
CORNERS
3/32 ALMOST SOFT
COVER WITH 1/32
SHEET - COVER
WITH COL. PAPER
POWER
20 STR. 1/8 BROWN
MAKE ADJUSTMENTS
CAREFULLY - MODEL
IS SENSITIVE - BUT
STABLE
3/32 SQ
1/4 x 1/16
CLARK Y 1/20 RIBS
118
F. Zaic
90 MINUTES TRACTOR ~ by LOCKTON PARK ~ SAN DIEGO, CALIF.

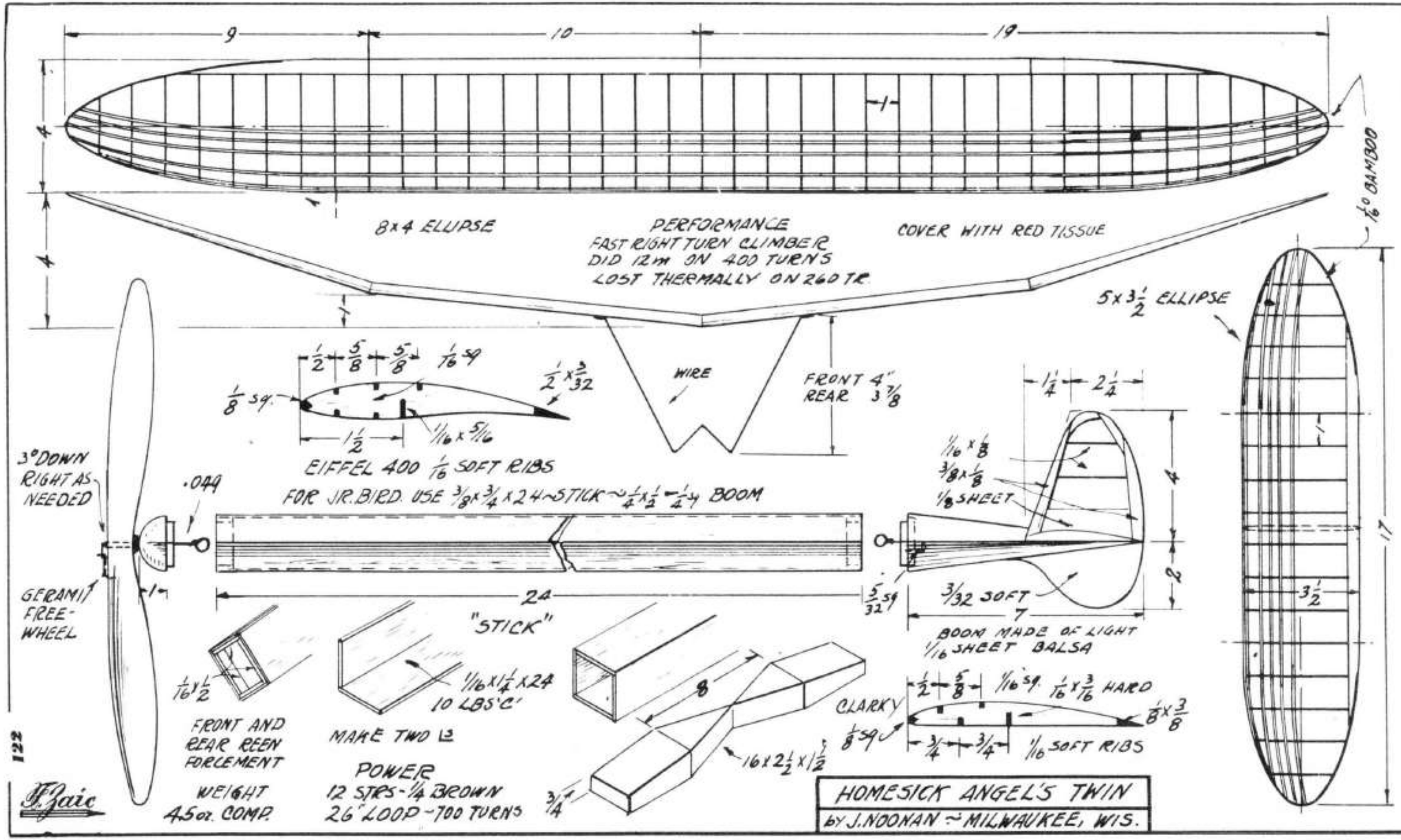

30m 21s TIME WAS MADE UNDER S.M.A.E.
O/S RULING - MODEL WAS ACTUALLY
FOLLOWED FOR 1¼ HRS. O/S
3° WING INCIDENCE
(ALL INFORMATION USED)
STORMONT 5-5
1/16 SOFT RIBS
TOTAL WEIGHT 4 oz.
POWER 8 STR. ¼ MRL
GERAMI'S FREEWHEEL
3/32 sq. STOCK
1/8 x 1/4 x 3/4 TO STEADY TAIL
STAB SECTION
THIN CLARK Y
A-A
B-B
C-C
TIME ~ 30m 21s
AUSTRALIAN OUTDOOR RECORD 'STICK'
by J. STORMONT ~ SYDNEY. N.S.W. AUS.

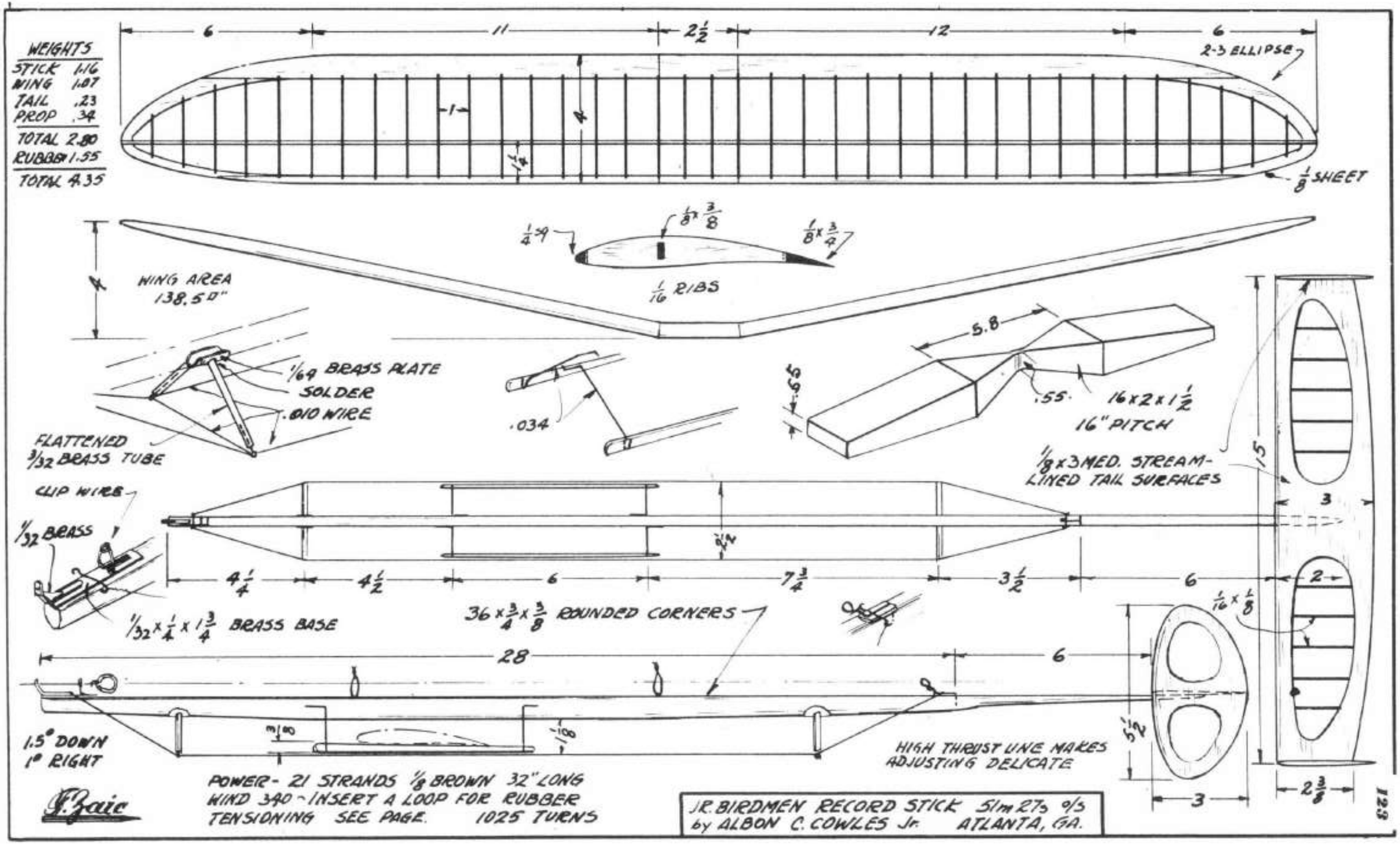


WEIGHTS
WING .50
ELEVATOR .27
STICK .64
PROPS .58
1.99
RUBBER 2.51
TOTAL 4.50
½ WING 15"
AREA 150 □"
½ ELEVATOR 10½
AREA 90 □"
MARQUARDT S-2
FOR AIRFOIL ORDINATES AND WING CONSTRUCTION SEE TEXT
25% GIVES SLIGHT WARPING STABILIZATION EFFECT
COVER THIS SIDE ORANGE-OTHER BLACK
MIXED COLORS HELP VISIBILITY
THIS SIDE ORANGE-OTHER BLACK
STICK
2-1/32 x 2 x 32 MED.
1/16 x 1 x 32 SOFT
COVER CROSS GR. ORANGE PAPER
BUILT-IN DIHEDRAL ½ OF ACTUAL BALANCE BENT NATURAL - SEE TEXT FOR INSTRUCTIONS
PERFORMANCE
1st MODEL 21m o/s
2nd " 1st FLIGHT 15m
2nd FLIGHT 7m o/s ABOVE TIMER
6 COATS OF DOPE
.035
SANDPAPER
APPROX 4"
ELEVATOR
RUBBER
JASCO F. WHEEL & B.B. WASHER
DOUBLE PAPER EXTRA DOPING IN & OUTSIDE BOTH ENDS
SOFT 1/16
LOWER HOOK
NOSE PLUGS CARVED FROM 1x1½x1½ SOFT HOLLOW & COAT WITH CEMENT
PROPS
15"-1.6 P/D MACHINE CUT RIGHT & LEFT FOR STICK MODEL ~14" FOR FUSELAGE
COVER WITH ORANGE PAPER DOPE THREE TIMES
DOTTED OUTLINE SHOWS FUSELAGE CONVERSION - MADE OF ELLIPTICAL BLKHDS AND STRINGERS
FOR FUSELAGE
POWER
10 STR. 3/16 BROWN
32" LOOP OR TO WT.
1400 TURNS
PUSH-PULL COMBINATION
by ROY MARQUARDT ~ BURLINGTON, IOWA
W. Zaic
120

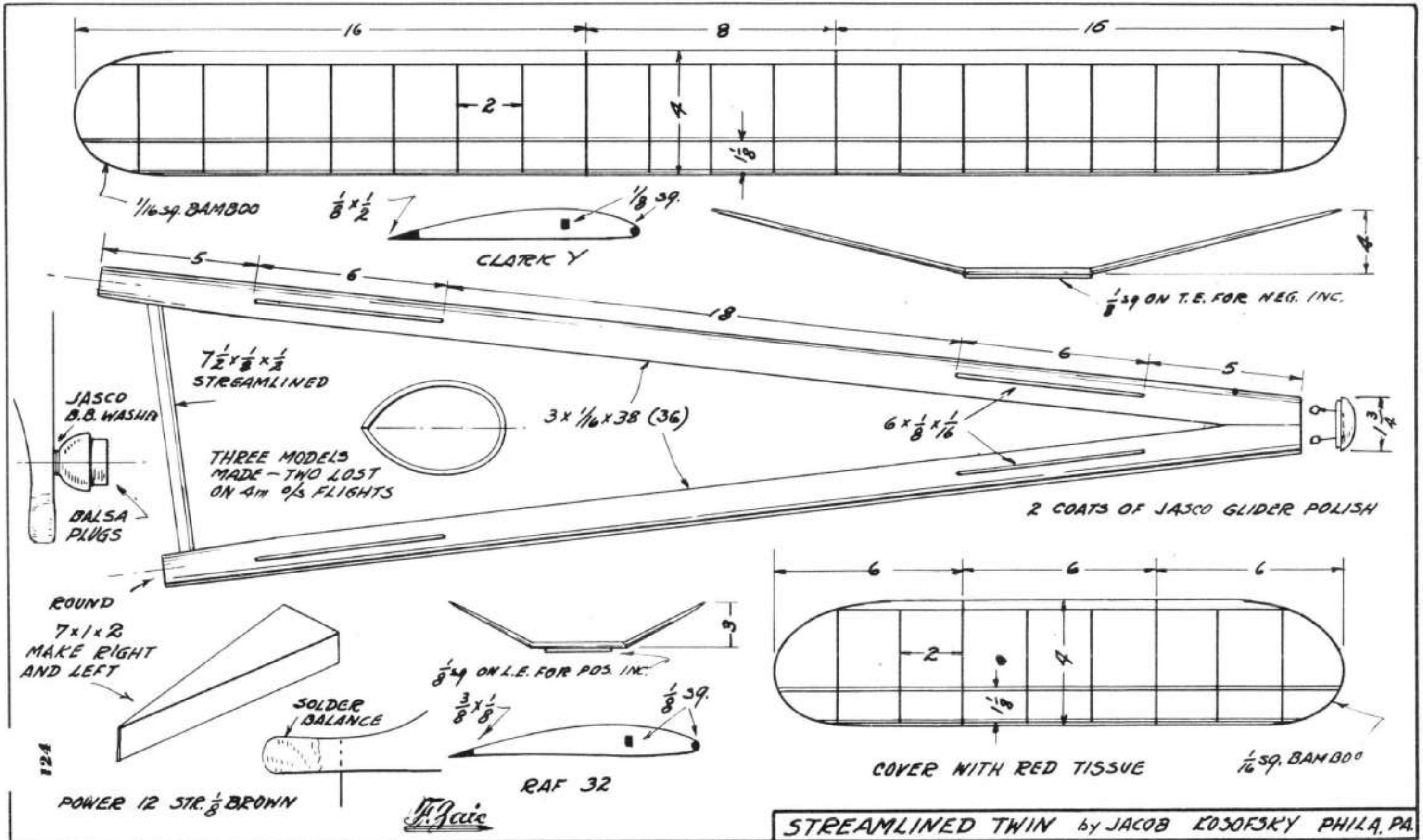


36
BAMBOO
DESIGNED BY MIKE KARLAK
18
BAMBOO
1/20 STOCK
1/16 SQ.
1/8 SQ.
3/16 x 7/16
POWER
33" LOOP OF
1/8 BROWN
PROP - 15 x 1 3/4 x 1 3/8
1/20 STOCK
1/16 SQ
1/8 SQ.
1/8 x 1/2
STABILIZER & RUDDER
(NEW RULE ONLY 2")
1/4 x 1/8 x 6 1/2
1/8 x 1/4 HARD
3/32 SQ. HARD
BAMBOO PIN FOR HOLDING
RUBBER MOTOR
TAIL BOOM
HELD ON
SCOTCH MEND. TAPE
WING MOUNT
21
6 5/8
1/16 RIB
AMER. RECORD 'C' TR.
TIME 36 m - O.O.S.
BUILT & FLOWN BY
HARRY WALKER
CLEVELAND OHIO

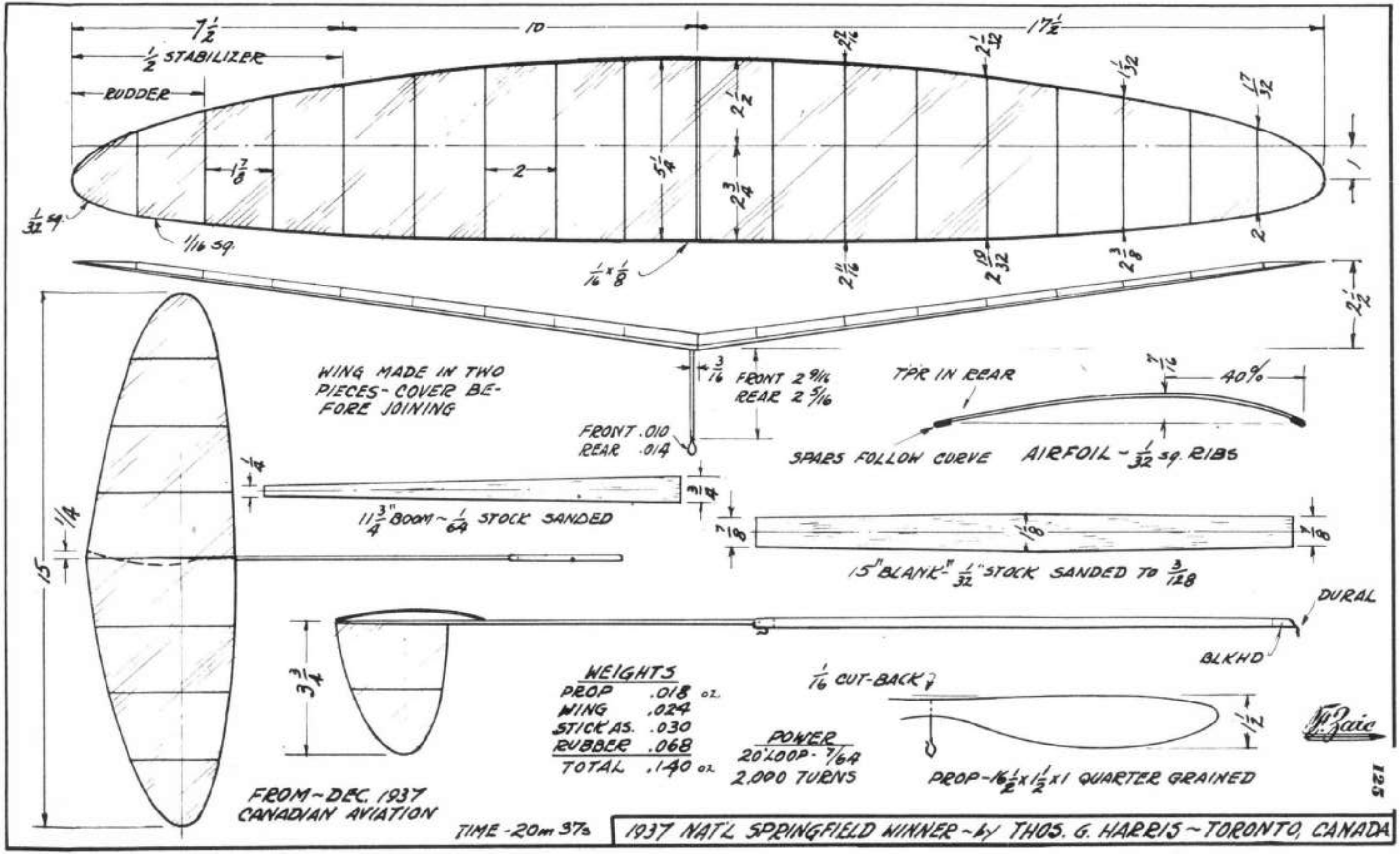

9
10
19
8x4 ELLIPSE
PERFORMANCE
FAST RIGHT TURN CLIMBER
DID 12m ON 400 TURNS
LOST THERMALLY ON 260 TR.
COVER WITH RED TISSUE
1/16° BAMBOO
5x3 1/2 ELLIPSE
WIRE
FRONT 4"
REAR 3 3/8
1/8 SQ.
1/2 5/8 5/8 1/16 SQ
2 1/2 x 3/32
1 1/2
1/16 x 5/16
EIFFEL 400 1/16 SOFT RIBS
3° DOWN RIGHT AS NEEDED
.044
FOR JR. BIRD. USE 3/8 x 3/4 x 24 ~ STICK ~ 1/4 x 1/2 ~ 1/4 sq BOOM
1 1/4 2 1/4
1/16 x 1/8
3/8 x 1/8
1/8 SHEET
3/32 SOFT
5/32 SQ
24
7
17
3 1/2
GERAMI FREE-WHEEL
"STICK"
BOOM MADE OF LIGHT 1/16 SHEET BALSA
1/16 x 1/2
FRONT AND REAR REEN FORCEMENT
1/16 x 1/4 x 24
10 LBS 'C'
MAKE TWO
8
16 x 2 1/2 x 1/2
3/4
CLARK Y
1/8 SQ
1/2 5/8 1/16 SQ. 1/16 x 3/16 HARD
1/8 x 3/8
3/4 3/4 1/16 SOFT RIBS
WEIGHT 4.5 oz. COMP.
POWER
12 STRS - 1/4 BROWN
26" LOOP ~ 700 TURNS
HOMESICK ANGEL'S TWIN
by J. NOONAN ~ MILWAUKEE, WIS.
F. Zaic



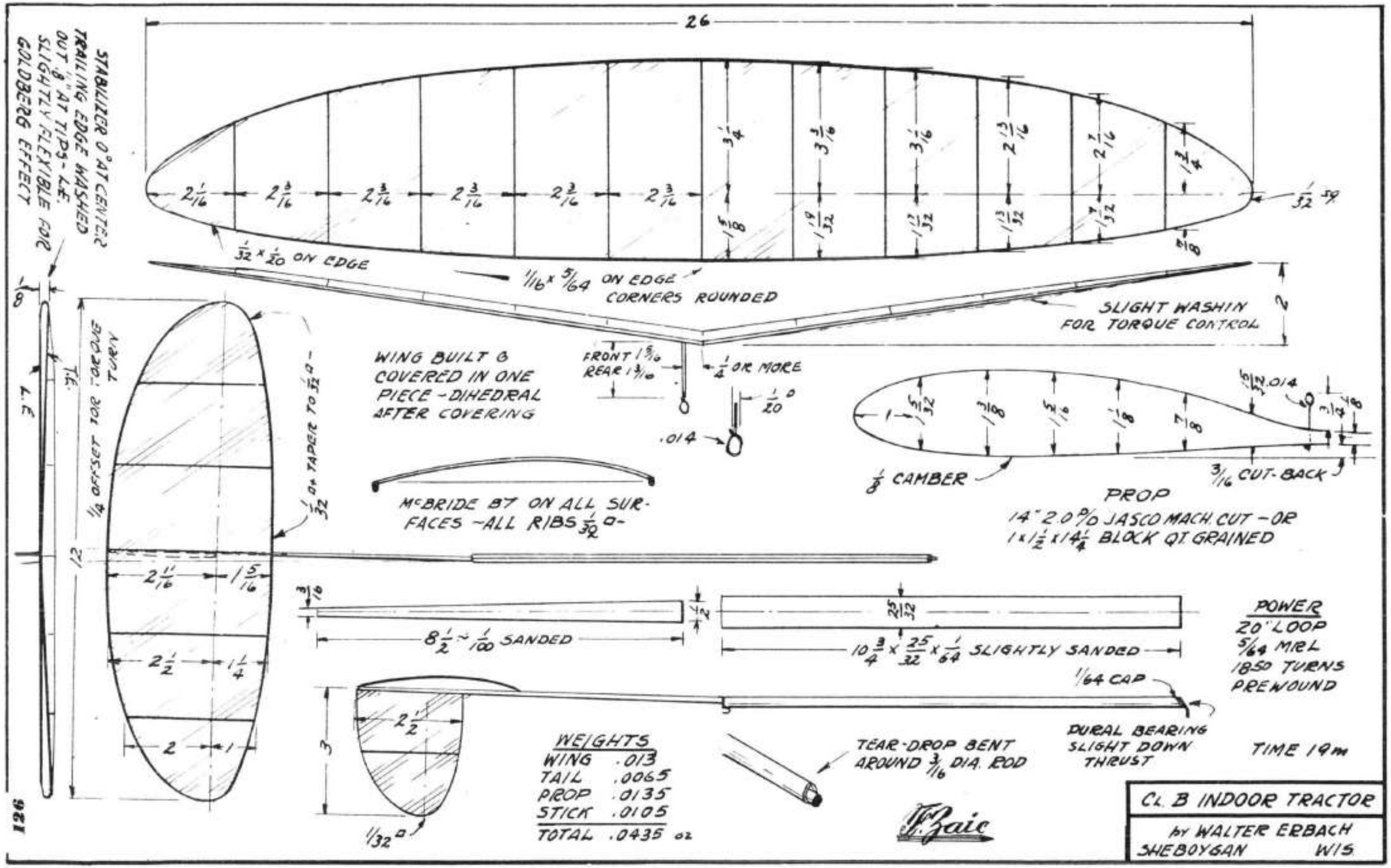
WEIGHTS
STICK 1.16
WING 1.07
TAIL .23
PROP .34
TOTAL 2.80
RUBBER 1.55
TOTAL 4.35
2-3 ELLIPSE
1/8 SHEET
1/8 x 3/8
1/4 SQ
1/8 x 3/4
1/16 RIBS
WING AREA 138.5 □"
1/64 BRASS PLATE
SOLDER
.010 WIRE
FLATTENED 3/32 BRASS TUBE
.034
5.8
.55
16 x 2 x 1 1/2
16" PITCH
1/8 x 3 MED. STREAM-LINED TAIL SURFACES
CLIP WIRE
1/32 BRASS
1/32 x 1/4 x 1 3/4 BRASS BASE
36 x 3/4 x 3/8 ROUNDED CORNERS
1.5° DOWN
1° RIGHT
HIGH THRUST LINE MAKES ADJUSTING DELICATE
POWER - 21 STRANDS 1/8 BROWN 32" LONG
WIND 340 - INSERT A LOOP FOR RUBBER
TENSIONING SEE PAGE. 1025 TURNS
JR. BIRDMEN RECORD STICK 51m 27s o/s
by ALBON C. COWLES Jr. ATLANTA, GA.

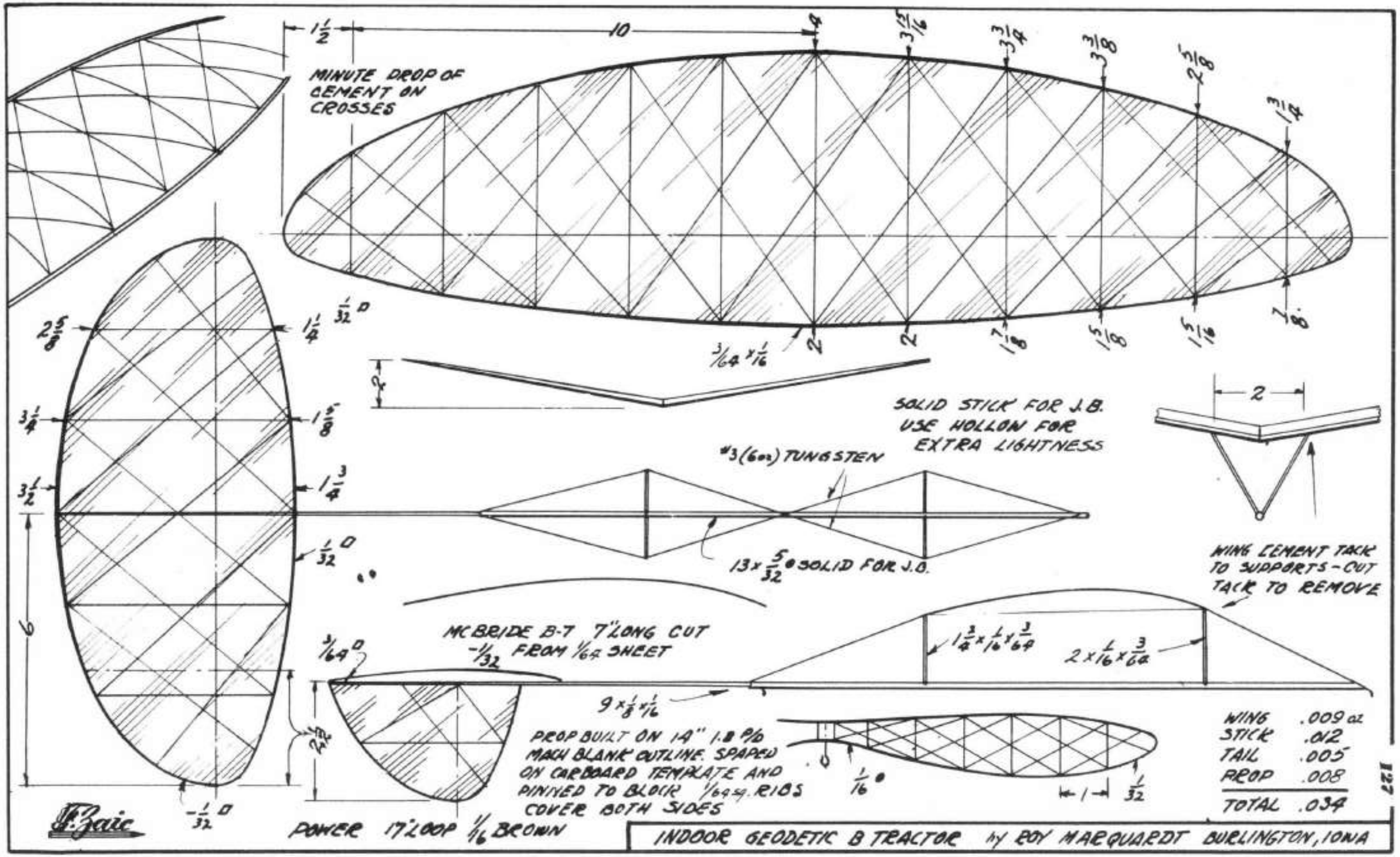


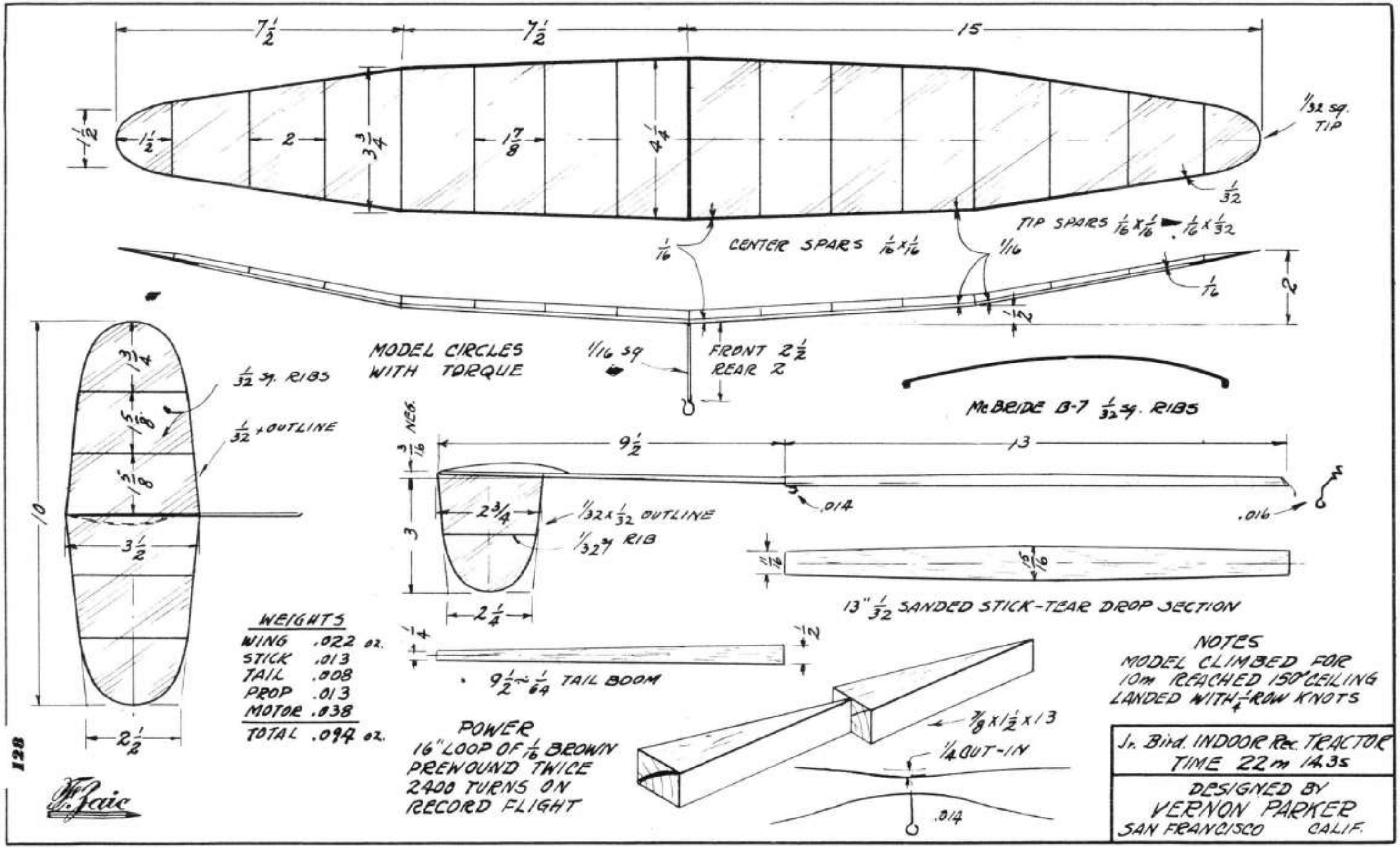
STREAMLINED TWIN by JACOB KOSOFSKY PHILA, PA.



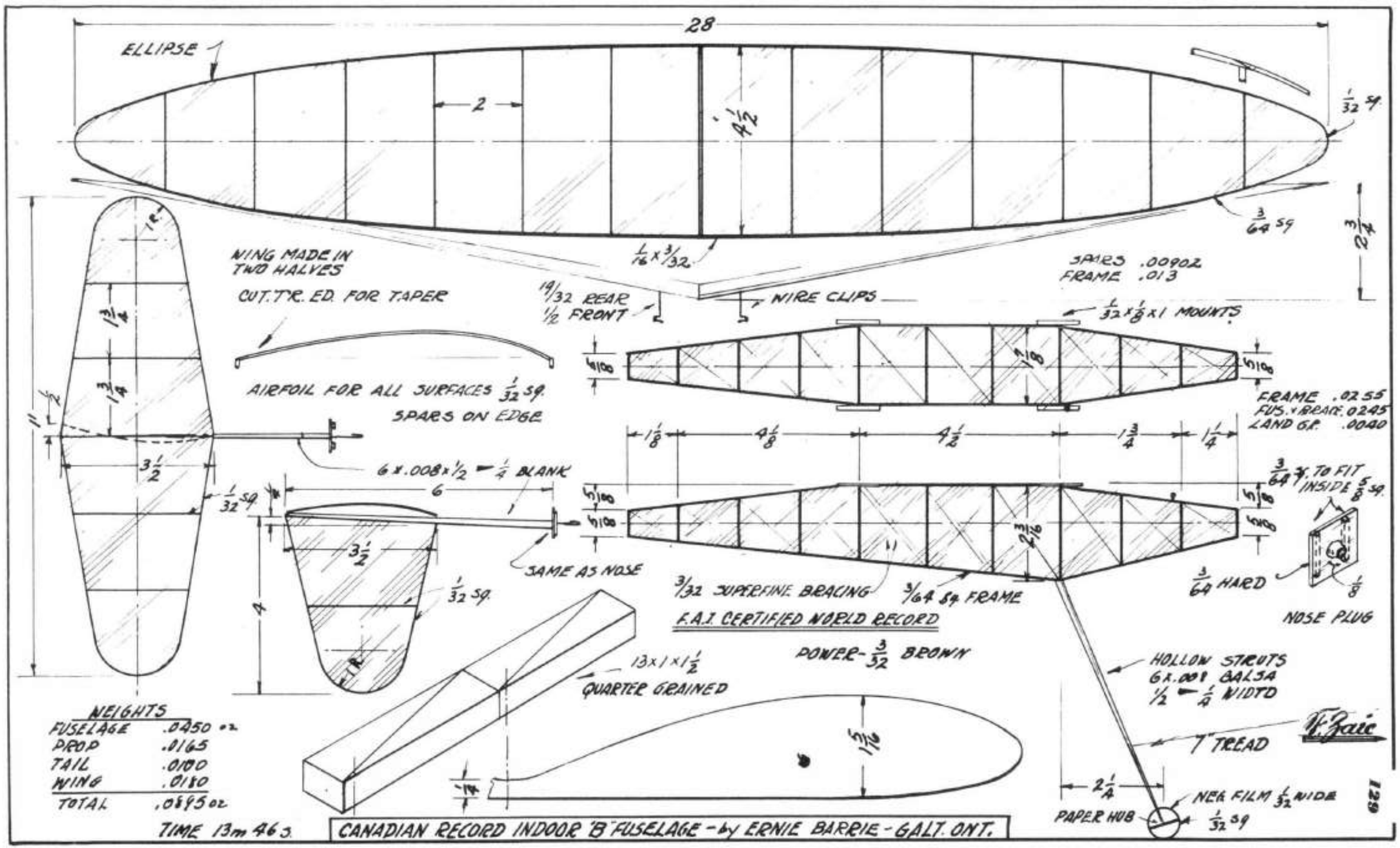
STABILIZER
RUDDER
WING MADE IN TWO PIECES - COVER BEFORE JOINING
FRONT 2 9/16
REAR 2 5/16
FRONT .010
REAR .014
TPR IN REAR
SPARS FOLLOW CURVE
AIRFOIL - 1/32 SQ. RIBS
40%
11 3/4" BOOM - 1/64 STOCK SANDED
15" BLANK - 1/32" STOCK SANDED TO 3/128
DURAL
BLKHD
WEIGHTS
PROP .018 OZ.
WING .024
STICK AS. .030
RUBBER .068
TOTAL .140 OZ.
POWER
20' LOOP - 7/64
2,000 TURNS
1/16 CUT-BACK
PROP - 16 1/2 x 1 1/2 x 1 QUARTER GRAINED
FROM - DEC. 1937 CANADIAN AVIATION
TIME - 20m 37s
1937 NAT'L SPRINGFIELD WINNER - by THOS. G. HARRIS - TORONTO, CANADA
125

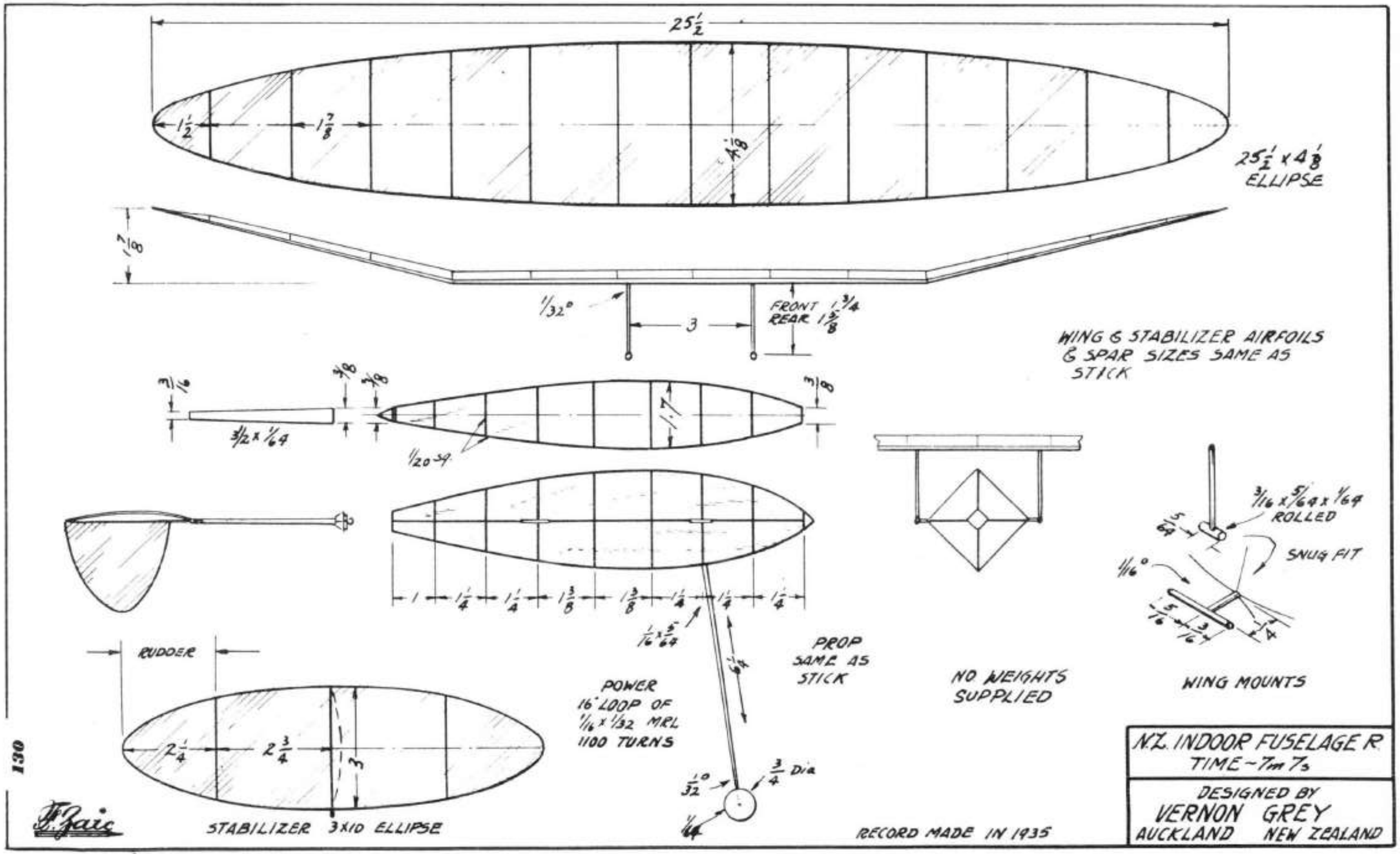

26
STABILIZER 0° AT CENTER
TRAILING EDGE WASHED OUT 1/8" AT TIPS - L.E. SLIGHTLY FLEXIBLE FOR GOLDBERG EFFECT
1/32 x 1/20 ON EDGE
1/16 x 5/64 ON EDGE CORNERS ROUNDED
SLIGHT WASHIN FOR TORQUE CONTROL
WING BUILT & COVERED IN ONE PIECE - DIHEDRAL AFTER COVERING
FRONT 1 5/16
REAR 1 3/16
1/4 OR MORE
1/20 □
.014
1/4 OFFSET FOR TORQUE TURN
1/32 □ TAPER TO 1/32 □
McBRIDE B7 ON ALL SURFACES ~ ALL RIBS 1/32 □
1/8 CAMBER
3/16 CUT-BACK
PROP
14" 2.0 P/D JASCO MACH. CUT - OR 1 x 1 1/2 x 14 1/4 BLOCK QT. GRAINED
8 1/2 ~ 1/100 SANDED
10 3/4 x 25/32 x 1/64 SLIGHTLY SANDED
POWER
20" LOOP
5/64 MR L
1850 TURNS
PREWOUND
1/64 CAP
DURAL BEARING SLIGHT DOWN THRUST
TEAR-DROP BENT AROUND 3/16 DIA. ROD
TIME 19m
WEIGHTS
WING .013
TAIL .0065
PROP .0135
STICK .0105
TOTAL .0435 oz
CL. B INDOOR TRACTOR
by WALTER ERBACH
SHEBOYGAN WIS.


MINUTE DROP OF CEMENT ON CROSSES
SOLID STICK FOR J.B. USE HOLLOW FOR EXTRA LIGHTNESS
#3 (6oz) TUNGSTEN
13 x 5/32 ⌀ SOLID FOR J.B.
WING CEMENT TACK TO SUPPORTS - CUT TACK TO REMOVE
MC BRIDE B-7 7" LONG CUT -1/32 FROM 1/64 SHEET
9 x 1/8 x 1/16
PROP BUILT ON 14" 1.8 P/D MACH BLANK OUTLINE SHAPED ON CARBOARD TEMPLATE AND PINNED TO BLOCK 1/64 sq. RIBS COVER BOTH SIDES
WING .009 oz
STICK .012
TAIL .005
PROP .008
TOTAL .034
POWER 17" LOOP 1/16 BROWN
INDOOR GEODETIC B TRACTOR by ROY MARQUARDT BURLINGTON, IOWA

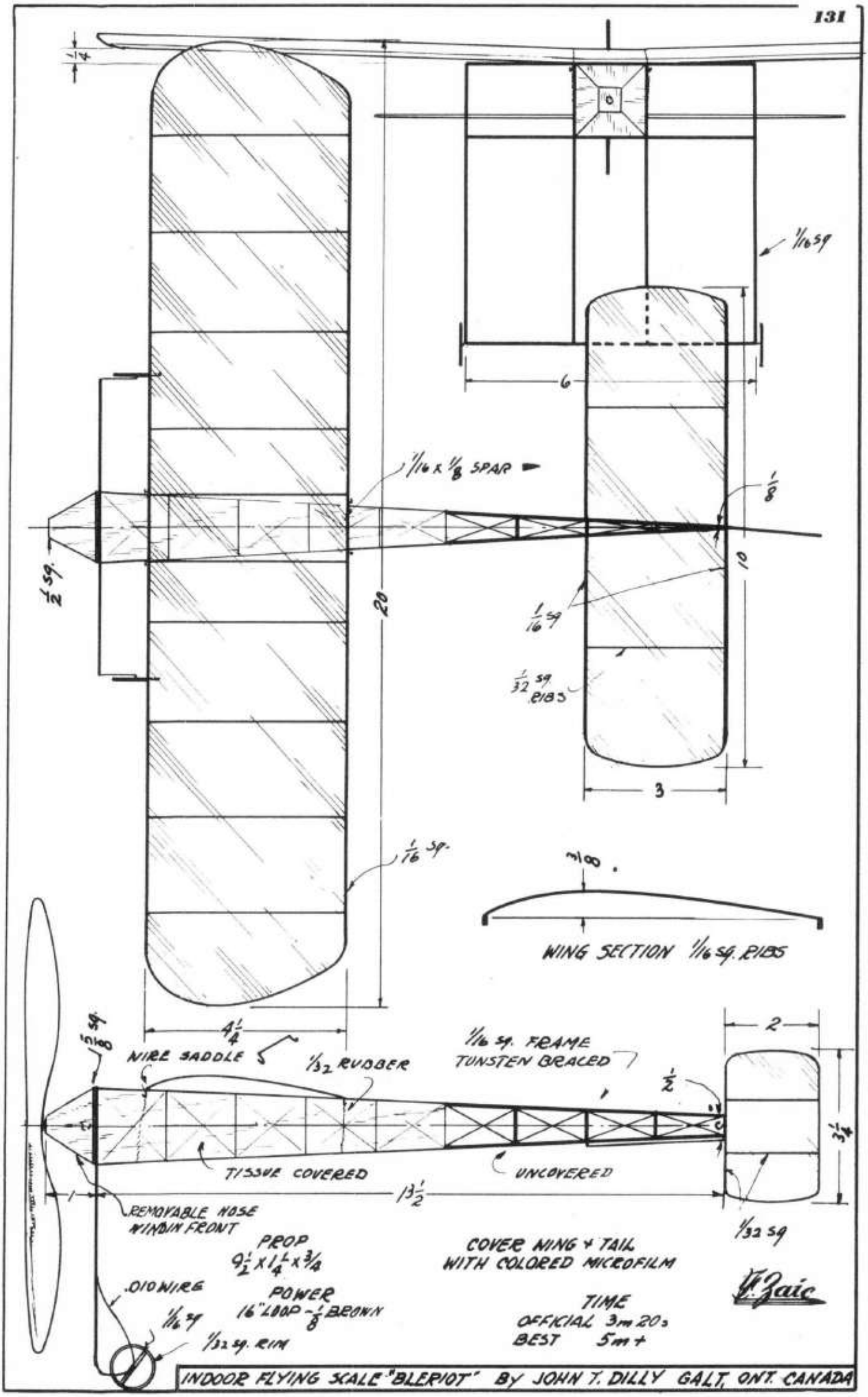


7 1/2
7 1/2
15
1/32 sq. TIP
1/32
TIP SPARS 1/16 x 1/16 ▶ 1/16 x 1/32
CENTER SPARS 1/16 x 1/16
1/16
1/16
1/16
2
1/2
MODEL CIRCLES WITH TORQUE
1/16 sq
FRONT 2 1/2
REAR 2
McBRIDE B-7 1/32 sq. RIBS
1/32 sq. RIBS
1/32 + OUTLINE
3/16 NEG.
9 1/2
13
.014
.016
1/32 x 1/32 OUTLINE
1/32 sq RIB
2 3/4
3
2 1/4
10
3 1/2
2 1/2
13" 1/32 SANDED STICK-TEAR DROP SECTION
9 1/2 x 1/64 TAIL BOOM
WEIGHTS
WING .022 oz.
STICK .013
TAIL .008
PROP .013
MOTOR .038
TOTAL .094 oz.
POWER
16" LOOP OF 1/16 BROWN
PREWOUND TWICE
2400 TURNS ON
RECORD FLIGHT
7/8 x 1 1/2 x 13
1/4 CUT-IN
.014
NOTES
MODEL CLIMBED FOR
10m REACHED 150' CEILING
LANDED WITH 1/4 ROW KNOTS
Jr. Bird. INDOOR Rec. TRACTOR
TIME 22m 14.3s
DESIGNED BY
VERNON PARKER
SAN FRANCISCO CALIF.

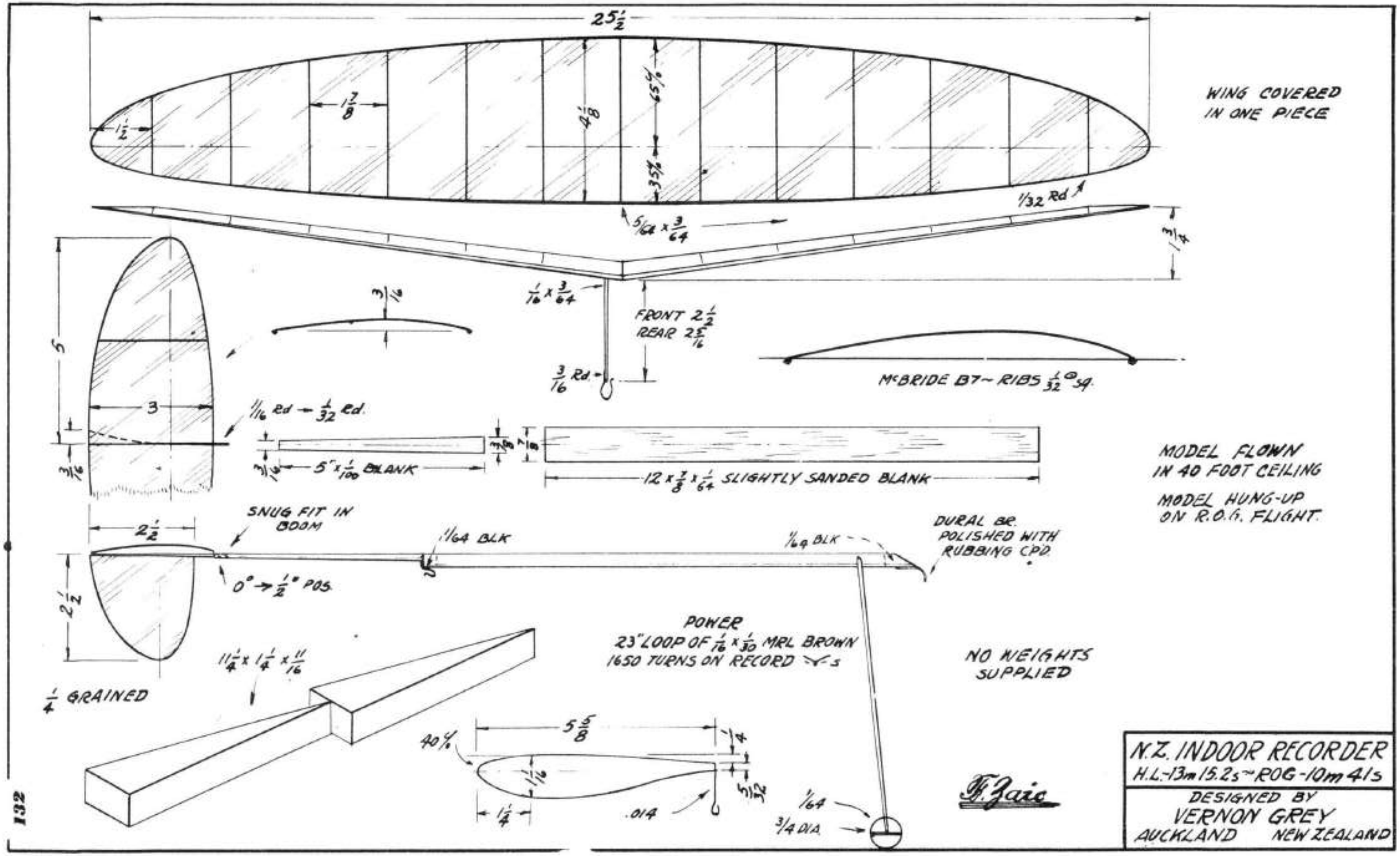

CANADIAN RECORD INDOOR 'B' FUSELAGE - by ERNIE BARRIE - GALT. ONT.
28
ELLIPSE
2
$4\frac{1}{2}$
$\frac{1}{32}$ SQ.
$\frac{3}{64}$ SQ
$2\frac{3}{4}$
$\frac{1}{16} \times \frac{3}{32}$
WING MADE IN TWO HALVES
CUT. TR. ED. FOR TAPER
$\frac{19}{32}$ REAR
$\frac{1}{2}$ FRONT
WIRE CLIPS
SPARS .00902
FRAME .013
$\frac{1}{32} \times \frac{1}{8} \times 1$ MOUNTS
AIRFOIL FOR ALL SURFACES $\frac{1}{32}$ SQ.
SPARS ON EDGE
FRAME .0255
FUS. + BRACE .0245
LAND GR. .0040
$1\frac{1}{8}$
$4\frac{1}{8}$
$4\frac{1}{2}$
$1\frac{3}{4}$
$1\frac{1}{4}$
$\frac{3}{64}$ SQ. TO FIT INSIDE $\frac{5}{8}$ SQ.
$\frac{3}{64}$ HARD
NOSE PLUG
$6 \times .008 \times \frac{1}{2}$ — $\frac{1}{4}$ BLANK
6
SAME AS NOSE
$\frac{3}{32}$ SUPERFINE BRACING
$\frac{3}{64}$ SQ FRAME
F.A.I. CERTIFIED WORLD RECORD
POWER - $\frac{3}{32}$ BROWN
$13 \times 1 \times 1\frac{1}{2}$
QUARTER GRAINED
HOLLOW STRUTS
6 x .008 BALSA
$\frac{1}{2}$ — $\frac{1}{4}$ WIDTH
7" TREAD
$2\frac{1}{4}$
PAPER HUB
NEG. FILM $\frac{1}{32}$ WIDE
$\frac{1}{32}$ SQ
11
$3\frac{1}{2}$
$1\frac{3}{4}$
4
WEIGHTS
FUSELAGE .0450 oz
PROP .0165
TAIL .0100
WING .0180
TOTAL .0895 oz
TIME 13m 46 s.
129

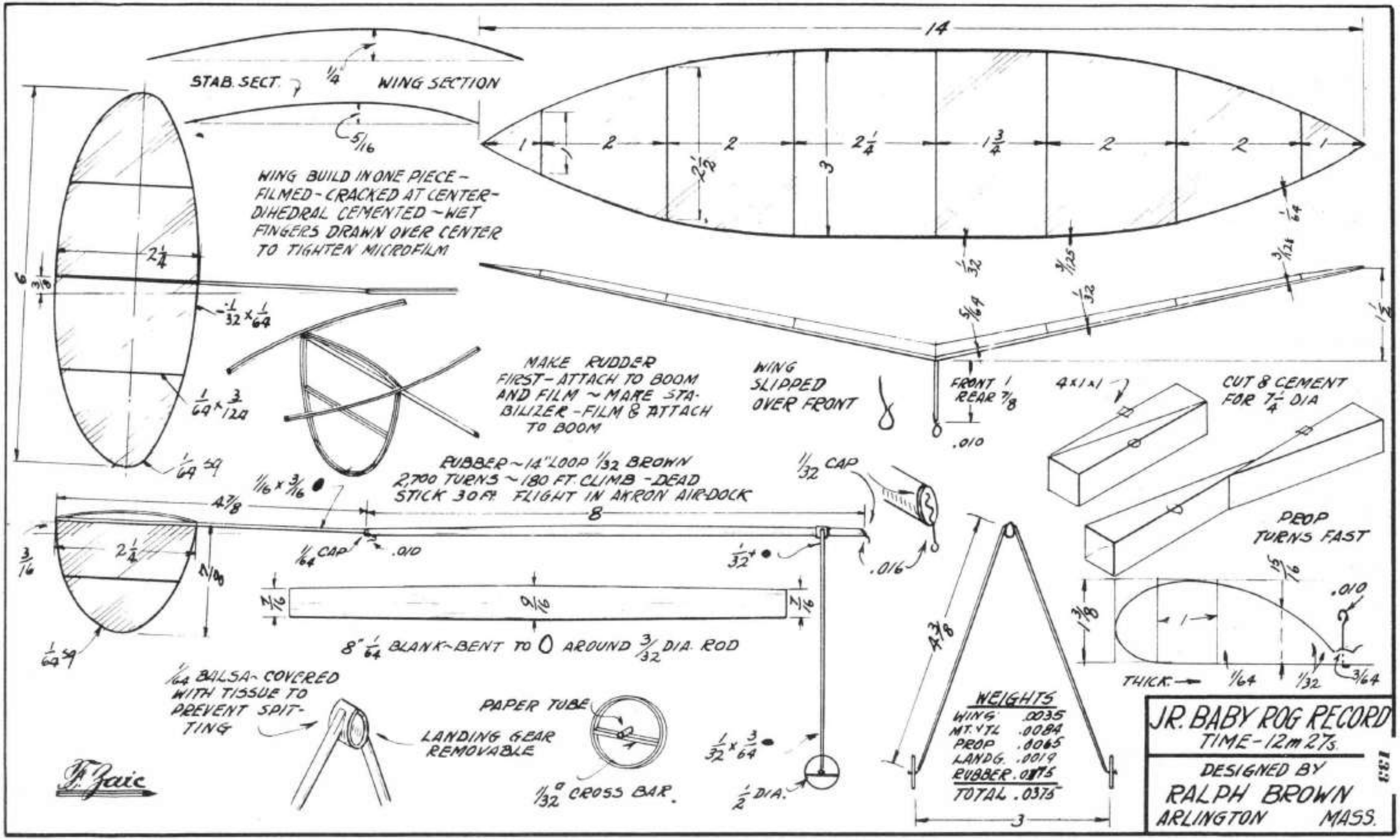


25½
25½ x 4⅛ ELLIPSE
FRONT 1¾
REAR 1⅝
WING & STABILIZER AIRFOILS & SPAR SIZES SAME AS STICK
RUDDER
PROP SAME AS STICK
POWER
16" LOOP OF 1/16 x 1/32 MRL
1100 TURNS
NO WEIGHTS SUPPLIED
WING MOUNTS
3/16 x 5/64 x 1/64 ROLLED
SNUG FIT
STABILIZER 3X10 ELLIPSE
RECORD MADE IN 1935
N.Z. INDOOR FUSELAGE R
TIME - 7m 7s
DESIGNED BY
VERNON GREY
AUCKLAND NEW ZEALAND

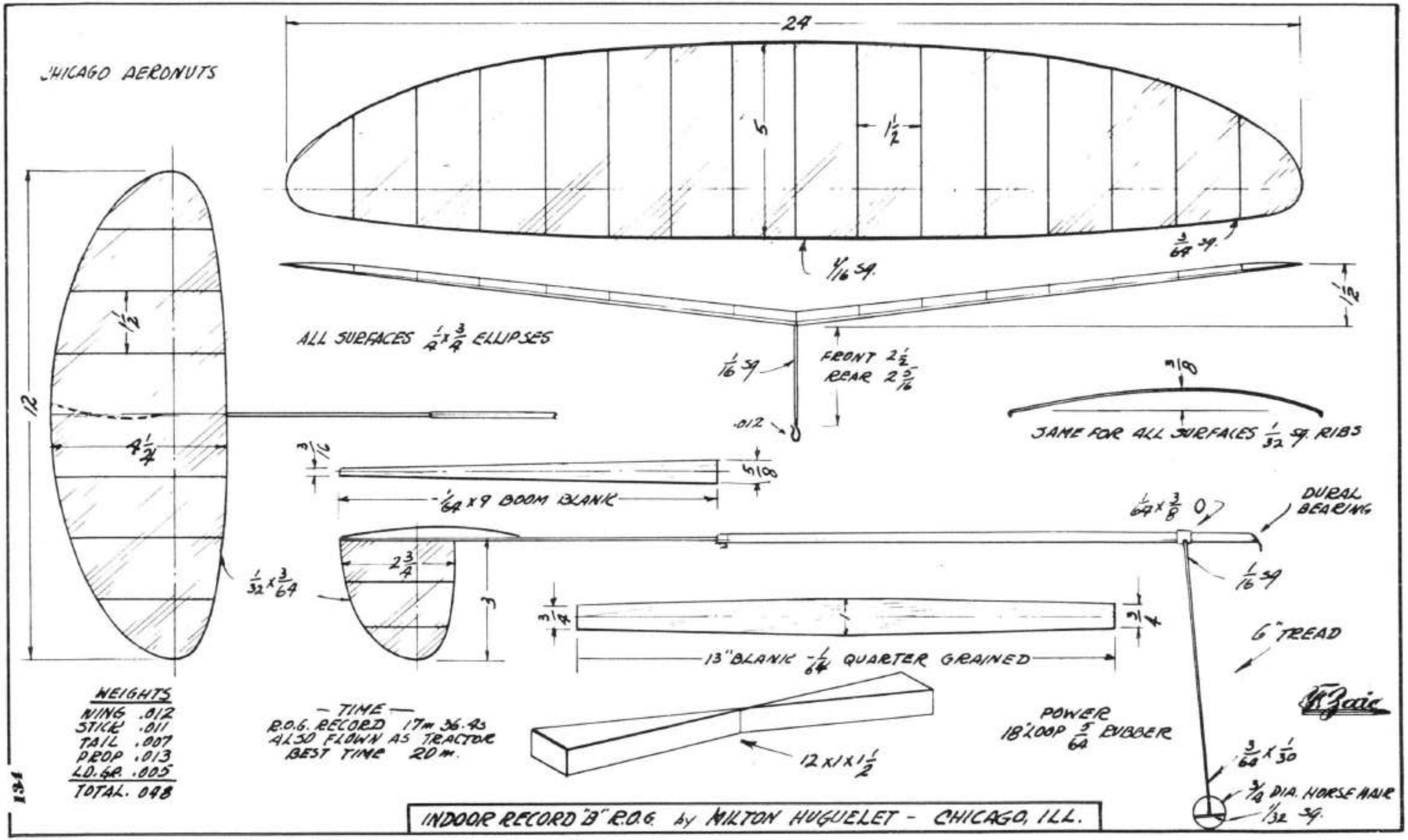


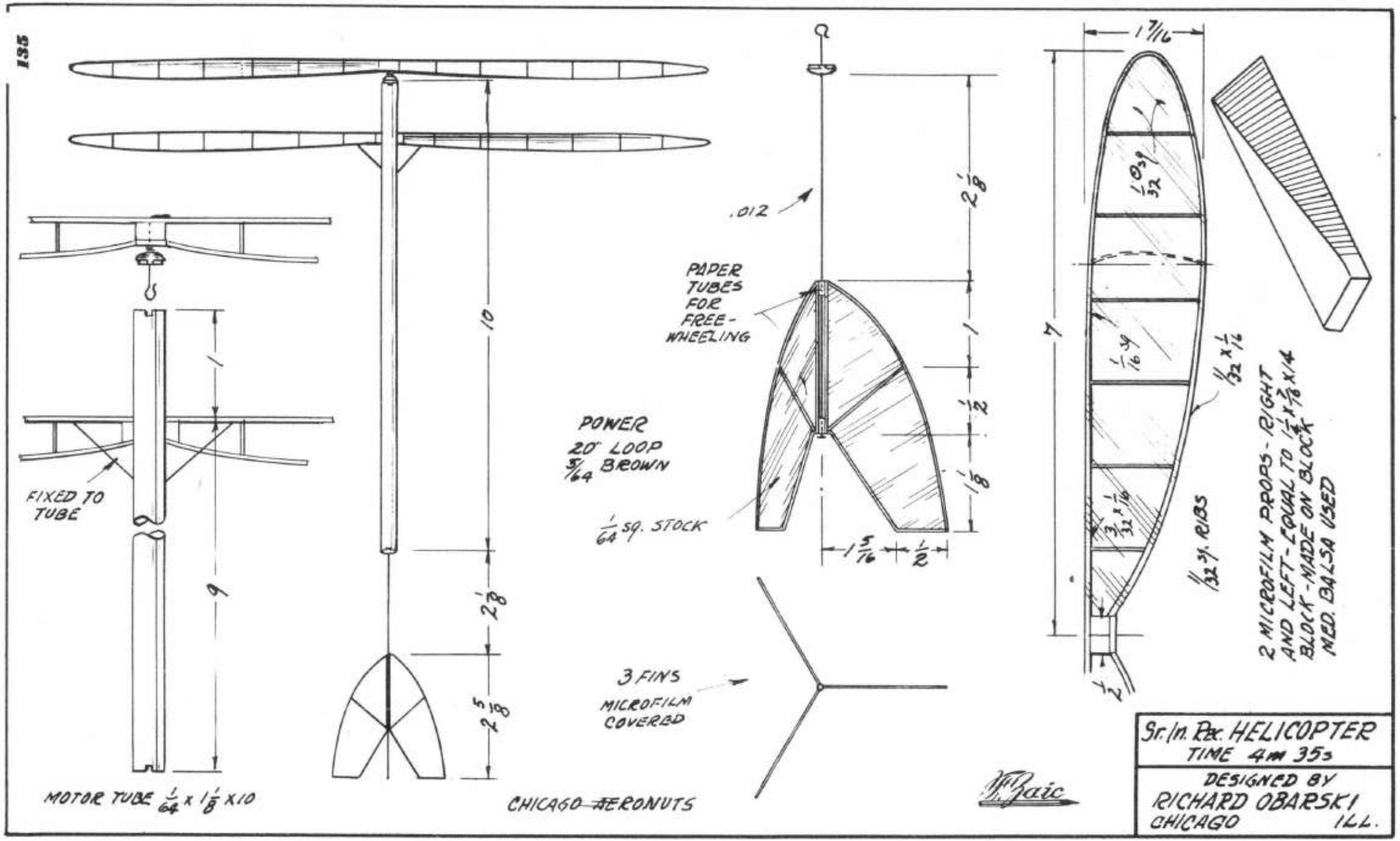
INDOOR FLYING SCALE "BLERIOT" BY JOHN T. DILLY GALT, ONT. CANADA


25 1/2
WING COVERED
IN ONE PIECE
1 1/2
1 7/8
4 1/8
65%
35%
1/32 Rd
5/64 x 3/64
1 3/4
5
3/16
1/16 x 3/64
FRONT 2 1/2
REAR 2 5/16
3/16 Rd.
McBRIDE B7 ~ RIBS 1/32 @ SQ.
3
1/16 Rd → 1/32 Rd.
3/16
3/16 ← 5" x 1/100 BLANK
3/8
7/8
12 x 7/8 x 1/64 SLIGHTLY SANDED BLANK
MODEL FLOWN
IN 40 FOOT CEILING
MODEL HUNG-UP
ON R.O.G. FLIGHT.
SNUG FIT IN
BOOM
2 1/2
1/64 BLK
1/64 BLK
DURAL BR.
POLISHED WITH
RUBBING CPD.
2 1/2
0° → 1/2" POS.
POWER
23" LOOP OF 1/16 x 1/30 MRL BROWN
1650 TURNS ON RECORD
NO WEIGHTS
SUPPLIED
11 1/4 x 1 1/4 x 11/16
1/4 GRAINED
5 5/8
40%
1/16
1/4
5/32
1 1/4
.014
1/64
3/4 DIA.
N.Z. INDOOR RECORDER
H.L.-13m 15.2s ~ ROG-10m 41s
DESIGNED BY
VERNON GREY
AUCKLAND NEW ZEALAND

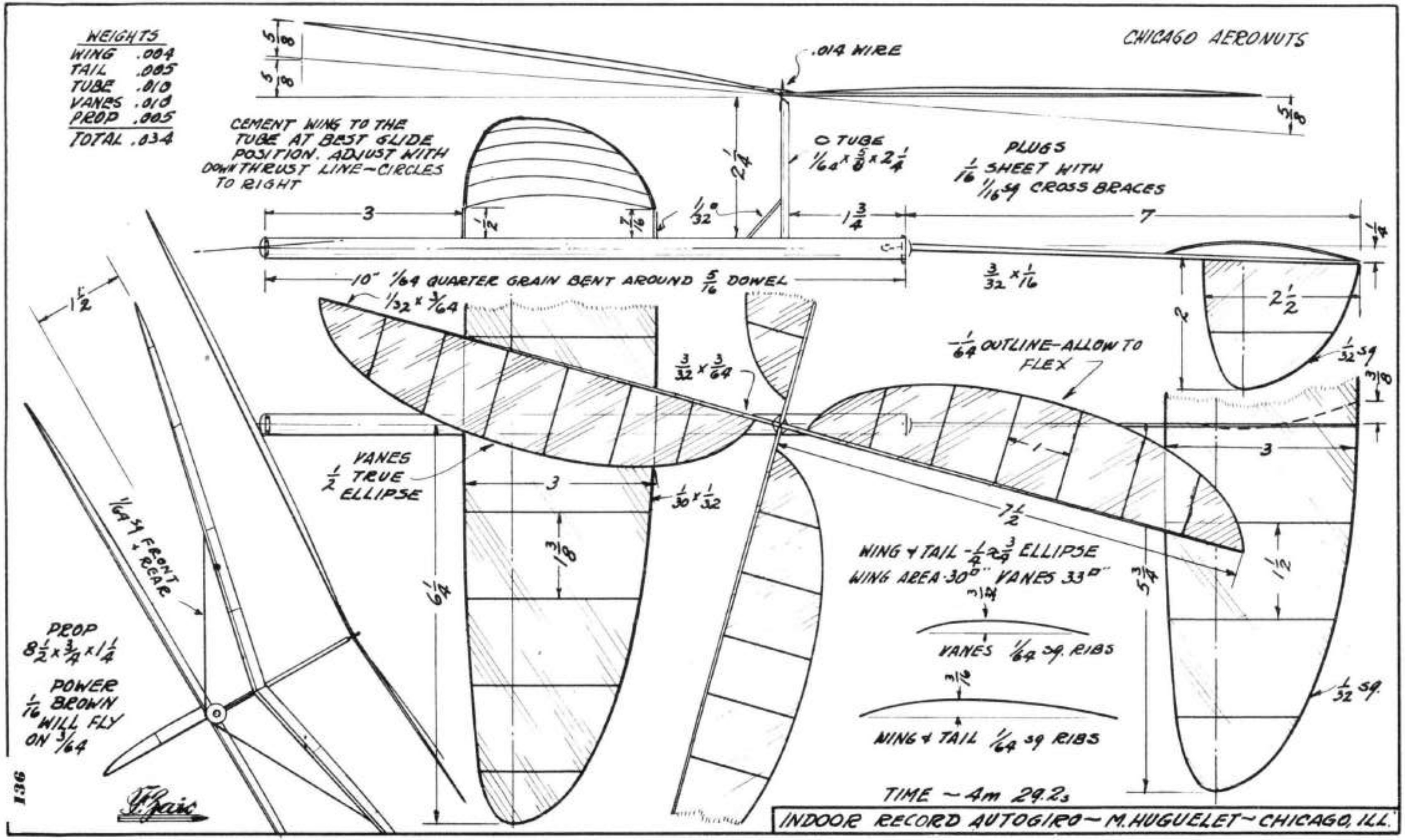


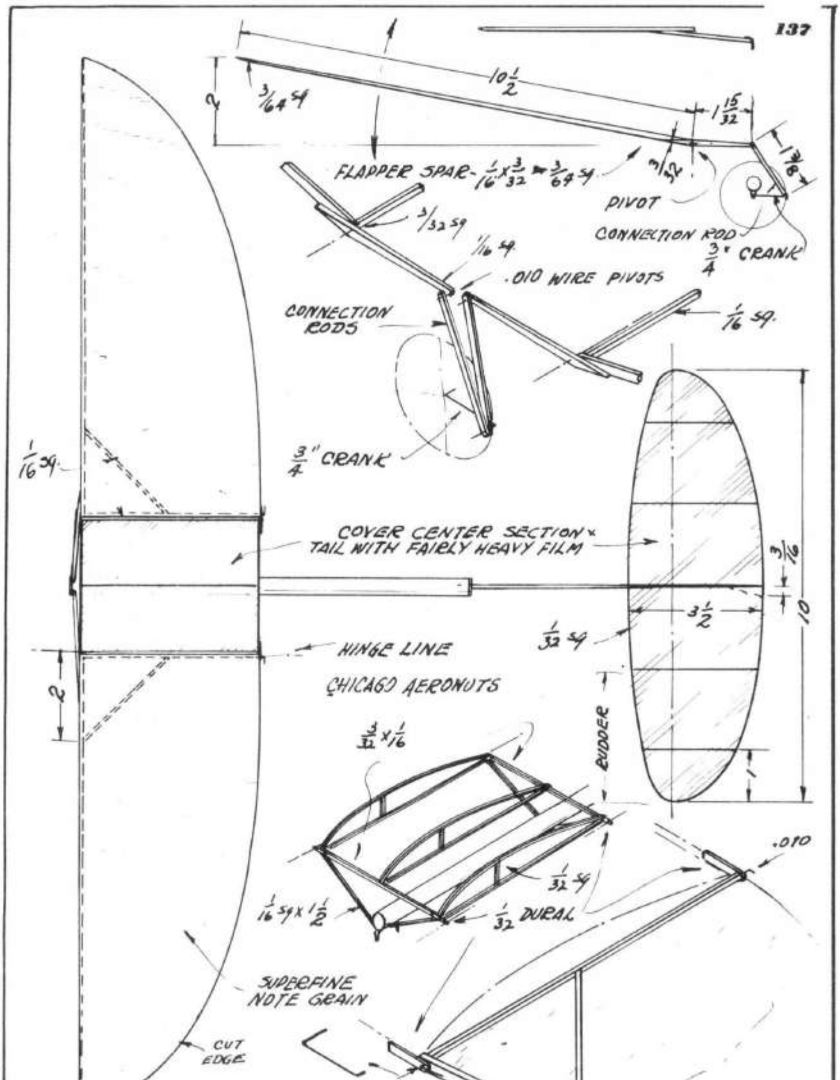
JR. BABY ROG RECORD
TIME-12m 27s.
DESIGNED BY
RALPH BROWN
ARLINGTON MASS.
14
STAB. SECT.
WING SECTION
WING BUILD IN ONE PIECE - FILMED - CRACKED AT CENTER - DIHEDRAL CEMENTED ~ WET FINGERS DRAWN OVER CENTER TO TIGHTEN MICROFILM
MAKE RUDDER FIRST - ATTACH TO BOOM AND FILM ~ MAKE STABILIZER - FILM & ATTACH TO BOOM
WING SLIPPED OVER FRONT
FRONT 1
REAR 7/8
CUT 8 CEMENT FOR 7 1/4 DIA
RUBBER ~ 14" LOOP 1/32 BROWN
2,700 TURNS ~ 180 FT. CLIMB - DEAD STICK 30 FT. FLIGHT IN AKRON AIR-DOCK
1/32 CAP
1/64 CAP
PROP TURNS FAST
8" 1/64 BLANK ~ BENT TO O AROUND 3/32 DIA. ROD
THICK.
1/64 BALSA ~ COVERED WITH TISSUE TO PREVENT SPITTING
PAPER TUBE
LANDING GEAR REMOVABLE
1/32 CROSS BAR.
1/2 DIA.
WEIGHTS
WING .0035
MT.+TL .0084
PROP .0065
LANDG. .0019
RUBBER .0175
TOTAL .0375


CHICAGO AERONUTS
24
5
1½
3/64 SQ.
1/16 SQ.
1/2
ALL SURFACES 1/4 x 3/4 ELLIPSES
1/16 SQ
FRONT 2½
REAR 2 5/16
.012
3/16
SAME FOR ALL SURFACES 1/32 SQ. RIBS
12
4¼
3/16
5/100
1/64 x 9 BOOM BLANK
1/64 x 3/8
DURAL BEARING
1/16 SQ
2¾
1/32 x 3/64
3
3/4
1
3/4
6" TREAD
13" BLANK 1/64 QUARTER GRAINED
WEIGHTS
WING .012
STICK .011
TAIL .007
PROP .013
LD. GR. .005
TOTAL. .048
— TIME —
R.O.G. RECORD 17m 36.4s
ALSO FLOWN AS TRACTOR
BEST TIME 20m.
12 x 1 x 1½
POWER
18" LOOP 5/64 RUBBER
3/64 x 1/30
3/4 DIA. HORSE HAIR
1/32 SQ.
INDOOR RECORD "B" R.O.G. by MILTON HUGUELET - CHICAGO, ILL.



FIXED TO TUBE
MOTOR TUBE 1/64 x 1 1/8 x 10
9
1
10
2 1/8
2 5/8
.012
PAPER TUBES FOR FREE-WHEELING
POWER
20" LOOP
5/64 BROWN
1/64 SQ. STOCK
1 5/16
1/2
1 1/8
1
2 1/8
3 FINS
MICROFILM COVERED
CHICAGO AERONUTS
1 7/16
7
1/32 SQ
1/16 SQ
3/32 x 1/16
1/32 SQ. RIBS
1/32 x 1/16
1/2
2 MICROFILM PROPS - RIGHT
AND LEFT - EQUAL TO 1 1/4 x 2/16 x 14
BLOCK - MADE ON BLOCK
MED. BALSA USED
Sr. In. Rec. HELICOPTER
TIME 4m 35s
DESIGNED BY
RICHARD OBARSKI
CHICAGO ILL.


WEIGHTS
WING .004
TAIL .005
TUBE .010
VANES .010
PROP .005
TOTAL .034
CHICAGO AERONUTS
.014 WIRE
CEMENT WING TO THE TUBE AT BEST GLIDE POSITION. ADJUST WITH DOWNTHRUST LINE—CIRCLES TO RIGHT
○ TUBE 1/64 x 5/8 x 2 1/4
PLUGS 1/16 SHEET WITH 1/16 sq CROSS BRACES
10" 1/64 QUARTER GRAIN BENT AROUND 5/16 DOWEL
1/32 x 3/64
3/32 x 3/64
3/32 x 1/16
1/64 OUTLINE—ALLOW TO FLEX
1/32 sq
VANES 1/2 TRUE ELLIPSE
1/30 x 1/32
1/64 sq FRONT + REAR
WING + TAIL - 1/4 - 3/8 ELLIPSE
WING AREA 30□" VANES 33□"
VANES 1/64 sq. RIBS
WING + TAIL 1/64 sq RIBS
PROP 8 1/2 x 3/4 x 1 1/4
POWER 1/16 BROWN WILL FLY ON 3/64
TIME ~ 4m 29.2s
INDOOR RECORD AUTOGIRO — M. HUGUELET — CHICAGO, ILL.


10 1/2
2
3/64 sq
1 15/32
1 3/8
FLAPPER SPAR- 1/16 x 3/32 → 3/64 sq
3/32
PIVOT
CONNECTION ROD
3/4" CRANK
3/32 sq
1/16 sq
.010 WIRE PIVOTS
CONNECTION RODS
1/16 sq.
3/4" CRANK
1/16 sq.
COVER CENTER SECTION ×
TAIL WITH FAIRLY HEAVY FILM
3/16
3 1/2
10
1/32 sq
HINGE LINE
CHICAGO AERONUTS
2
RUDDER
1
3/32 x 1/16
.010
1/32 sq
1/16 sq x 1 1/2
1/32 DURAL
SUPERFINE
NOTE GRAIN
CUT
EDGE
.010 WIRE
4 1/2
5
6 3/4
9/32
9/16
1/32 CAPS + BLKHD
3/32 x 1/16
3/64 sq
1/4
3
3
DURAL BEARING
1" x 9 1/2 x 1/32 BLANK BENT
AROUND 3/8" DOWEL
POWER
12" LOOP ~ 7/64 RUBBER
1000 TURNS ON RECORD
TIME
4m. 19.2s
K. Zaic
INDOOR RECORD ORNITHOPTER by DENNIS TURNER- CHICAGO ILL

SPECIAL NOTES ON MODELS SHOWN AS GLEANED FROM CORRESPONDENCE

Page 66 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 foreward 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, althought 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 ina 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.

Page 94 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 wammer 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 fusdage with rubber tensioner combination is better for purely duration models. I might mention that I nad 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."

Page 82 J.E.Adams Geared Wakefield Entry

"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 nottake 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."

Page 96 Fred Mayfield Paper Maché

"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."

Page 112 Jacob Kosofsky Twin Pusher

"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."

Page 102 Norman C. Schaller Push-Pull Fuselage

"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 1¾ 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 shjp 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 streched 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 largr 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 d ive 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 consistant 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.

Page 103 Richard Schumacher Brown - 3 Flying Scale

" 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 pr perly tuned up.

Incidently, 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 manucatured 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 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.
(Fidelity to the authentic drawing, fuselage, wings, empenage, landing gear)

Power plant, etc.----------100 pts.
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.

Page 81 Frank Zaic 1937 Wakefield Entry

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.

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

INDOOR

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 Micott	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 Huguelet	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.	25m 29s
OP:	Carl Goldberg	Chicago, Ill.	23m 29.3s

CABIN FUSELAGE CLASS 'B'

RISE OFF GROUND

JR:	John Stokes, Jr.	Huntingdon Val. Pa.	14m 15.3s
SR:	Charles Heints	Philadelphia, Pa.	13m 15.3s
OP:	John Ginaetti	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 Huguelet	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.	58.4s
OP:	Carl Goldberg	Chicago, Ill.	47.5s

AUTOGIROS, Launching Optional No Classes

JR:	Milton Huguelet	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

ORNITHOPTERS, Launching Optional, No Classes

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

OUTDOOR

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:	Bernarr 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 Fullmer	Camillus, N.Y.	41m 30.5s
OP:	R.H. Bodle	Akron, Ohio	1m 51s

RISE OFF WATER

SR:	Roy E. Stoner	Rockford, Ill.	1m 12s

CABIN FUSELAGES CLASS 'D'

RISE OFF GROUND

JR:	Robert Guilfoy	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

GASOLINE POWERED FUSELAGES CLASS 'E'

RISE OFF GROUND *(300 sq. in. and over)*

SR:	Fiske Hanley	Fort 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 File	Columbus, Ohio	23m 13s
OP:	Everett Tasker	Boston, Mass.	4m 25s

OUTDOOR GLIDERS CLASS 'D'

HAND LAUNCHED

SR:	Edward L. Smith	Jacksonville, Fla.	38s

TOW LINE LAUNCHED

JR:	Paul Durup	Boston, Mass	57.8s
SR:	Dick Everett	Elm Grove, W.Va.	2m 38s
OP:	Roland Buhrig	Canostota, N.Y.	1m 18s

OUTDOOR GLIDERS CLASS 'E'

TOW LINE LAUNCHED

SR:	Jack Smith, Jr.	Dayton, Ohio	1m 23.4s

AUTOGIROS, Launching Optional, No Classes

SR:	Sanford Clevinger	Kansas City, Mo.	21.4s

HELICOPTERS, Launching Optional, No Classes

SR:	Glen O'Roak	Boston, Mass.	15s

ORNITHOPTERS, Launching Optional, No Classes

SR:	Leonard Elgenson	Chicago, Ill.	6s

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.

GAS MODEL PLANS

WAKEFIELD PLANS

OUTDOOR FUSELAGES PLANS

OUTDOOR STICK PLANS

INDOOR STICK PLANS

INDOOR FUSELAGE PLANS

INDOOR R.O.G. PLANS

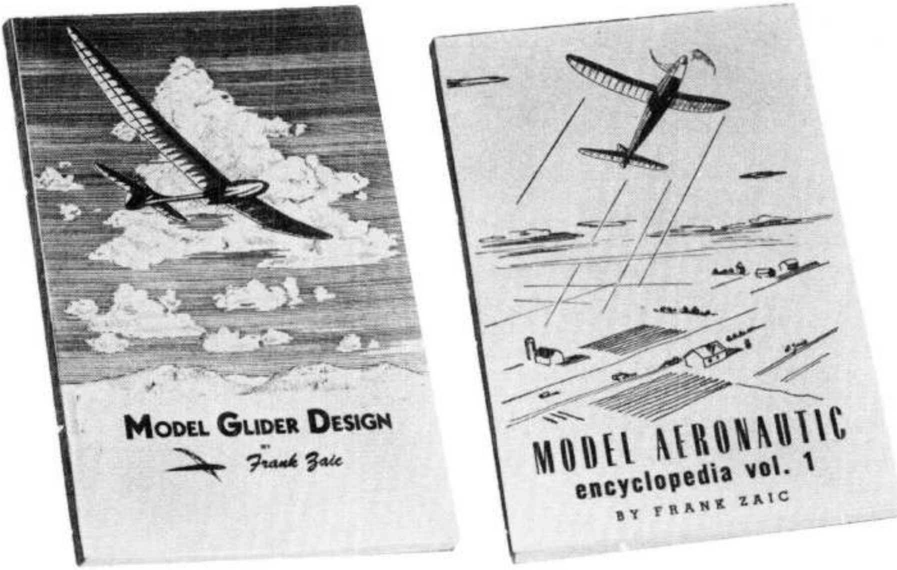
HELICOPTER

AUTOGIRO

ORNITHIPTER

CONTRIBUTIONS

GENERAL THEORY & PRACTICE



If you have the above two books and this Volume #2, you have the world's most complete collection of data on Model Aerodynamics and a grand total of 220 plans of every type of model known. If you lack one of them, it can be obtained from your dealer or direct. The price is $1.00 each, Postpaid.

At present we only have three books. We would like to prepare and publish a new Year Book, but circumstances are not very favorable right now. We will advertise it when and if it is published.

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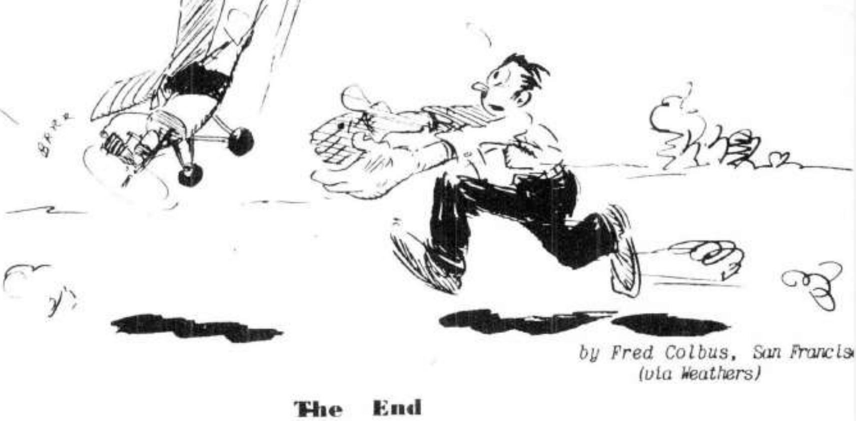

by Fred Colbus, San Francisco
(via Weathers)

The End