NMPRA

PYLON RACING BOOK

Official Publication
of the
National
Miniature Pylon Racing
Association

NATIONAL MINIATURE PYLON RACING ASSOCIATION
NMPRA

NMPRA PYLON RACING

Compiled by the Southern California District

of the

National Miniature Pylon Racing Association

PREFACE

The National Miniature Pylon Racing Association was formed in 1965 as the governing body for model pylon racing in the United States, to work with the Academy of Model Aeronautics in formulating rules and regulations for the flying of miniature pylon racers. To give a picture of the activities of NMPRA and to aid in the construction and racing of these aircraft, the Southern California District of NMPRA has prepared this pylon racing book, receiving cooperation from leading fliers in the U.S. who have expertise in different areas of pylon racing and who are willing to share their knowledge.

NMPRA is a division of the Academy of Model Aeronautics, which is the governing body for all model aircraft activities in the United States. With a membership of over fifty thousand, it is one of the largest branches of the National Aeronautics Association, which govern all aspects of sport aviation in America. The AMA is also a member of the Federation Aeronautique Internationale, the world-wide representative of sport aviation, and the sponsor of World Championships in all categories of modeling as well as full-size aircraft, ballooning, etc.

Membership in the Academy is open to anyone interested in model aircraft. Membership in AMA is a requirement for joining NMPRA. Applications may be addressed to:

Academy of Model Aeronautics
806 Fifteenth Street, N.W.
Washington, D.C. 20005

Included in membership fees are insurance, rule books, and miscellaneous benefits pertaining to general or specialized interests.

Membership in NMPRA may be obtained by writing to the Secretary-Treasurer:

Mr. Gil Horstman
E. 11223 La Crosse St.
Spokane, Washington 99206

The Southern California District wishes to thank the authors of the articles in this book for sharing their expertise, and the committee members for giving freely of their time and efforts. Committee members are:

Terry Prather, Chairman
Bob Stockwell
Bob Upton
Al Prather
Dick Tichenor, Photos
Bror Faber
Joe Stream
Betty Stream

GRAND CHAMPIONS

To recognize outstanding ability in the flying of miniature pylon racers in competition, the NMPRA yearly confers the title of Grand Champion. The championship is awarded on the basis of a national point system administered by the district vice presidents and the national president.

The Grand Championship was first awarded in 1968 and went to Granger Williams. In 1969, while he was still in the junior class, it went to Whit Stockwell. A tie in 1970 gave the award jointly to Larry Leonard and Terry Prather. In 1971 there was no Grand Championship awarded. In the Southern California District the Formula I Championship was taken by Terry Prather, and in the Northeast District Formula I was taken by Adam Sattler, Formula II by Kent Landefelt, and Northeast Grand Championship by Hal deBolt. In 1972, under a revised system of point accumulation, the grand championship was won by Bob Smith.

Bob Smith 1972 Grand Champion and his winning Miss Dara Formula I racer

Terry Prather 1970 Co-Grand Champion holding his 1971 Nats winning Minnow

Larry Leonard 1970 Co-Grand Champion and his Miss BS FAI racer at 1971 Nationals

Whit Stockwell 1969 Grand Champion with Stafford Minnow.

Granger Williams 1968 Grand Champion and his winning Formula I Miss San Bernardino

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Historical Notes on the Racing of Full-Scale Formula I Aircraft
by John Brodbeck

John Brodbeck

The following is a report of an interview with *John Brodbeck,* the "B" of "K & B Aurora," himself not only a pioneer in model aviation and one of the major supporters of miniature pylon racing today, but also far more than a spectator in the early days of Goodyear Racing, later known as Formula I. The interview was conducted by *Bob Stockwell,* editor of the Newsletter of the National Miniature Pylon Racing Association 1970-72, pylon columinst for the *American Aircraft Modeler,* and pit crew on one of the leading R/C pylon racing teams.

Q: John, I understand you were once chief starter for the Reno Air Races.

B: Actually, I had that responsibility for three years in a row: 1966, 1967, and 1968, except for the Unlimited Class.

Q: I guess you've had a chance to meet most of the famous names in pylon racing. You must have quite a store of yarns to tell about it. Is there any particular race that stands out most vividly in your memory?

B: Well, the race when Art Chester was killed is the most vivid one, probably because my brother Bill was flying in it. In fact, when Art went in, he was flying Sweet Pea, a V-tailed aircraft; and the only other one in that heat with a V-tail was Bill's plane, Sky Baby, and I was scared sick that it might have been him.

Q: How did the accident happen?

B: Just before the race, Art Chester was giving my brother some tips on flying the midget racers. After all, you don't have a chance to get "checked out" in one of them: when you squeeze into that tiny cockpit, you're on your own. Art especially warned my brother not to pull a turn too close to another aircraft because of the extreme turbulence which was capable of making it very difficult to control those squirrelly little birds. It was maybe half an hour later when Art got caught in exactly that situation, started to flip on his back, quickly corrected and went over the other way straight into the ground.

Q: What year was that?

B. 1949, in San Diego.

Q: How long had the event been running then?

B: Though the first Midget Pylon Races weren't until 1947, the Professional Racing Pilots Association was founded informally in 1939 and incorporated in 1946 with Art Chester as their first president. They were the ones who developed and nourished the event. The first members, the real founders and spark plugs besides Chester, were: Benny Howard, Steve Wittman, Tony LeVier, Fish Salmon, Bill Robinson, and Charlie Tucker. They somehow managed to talk the Goodyear Tire and Rubber Company into putting up $75,000 for three years of races, at $25,000 per race, at the Cleveland Air Races.

Q: What sort of arguments did they use to persuade Goodyear to put up money for a new event like that?

B: I think the main selling point to Goodyear was that the Midget races would be in full view of the spectators all the way around the course. You see, the National Air Races with planes like the P-51 and P-38 were held on a 9-mile course. The spectators would see the big ones roar by on the straightaway closest to the stands, and then watch them disappear. Much of the excitement took place where it couldn't easily be seen. But the Midget racers would cover a 4-pylon course of only 2.2 miles, with the whole event in full view.

Q: Did Goodyear put any restrictions on their offer?

B: Well, the PRPA had to guarantee that there would be enough entries to make the event interesting and competitive. No specific number was stipulated, but they managed to come up with 13 planes for the first race, and that satisfied the Goodyear people.

Q: What sort of limitations did PRPA put on the event? What kind of plane would qualify to enter?

B: They were all hand-built machines, limited to engines displacing 190 cubic inches, with fixed propellers and fixed landing gear, with an empty weight of 500 pounds. In that 1947 race, the first Goodyear Race ever, the winning speed was 165.857 m.p.h. It was won by Bill Brennand, followed by Paul Penrose, Fish Salmon, Tony LeVier, and Warren Siem.

Q: How come the event isn't still called "Goodyear Pylon Racing"?

B: Goodyear withdrew their sponsorship of air racing after the 1949 races when there was a serious accident. After that the PRPA managed to find various individual and corporate sponsors, like Continental Motors at $15,000 a year for two years in Miami. It was just called "Midget Pylon Racing" until the name of the event was changed to "Formula I" in 1967. That was the same year they changed to the 200 cubic inch Continental engine, previously having been restricted to the 190 cubic inch Continental C-85.

Q: How much did the speeds go up over this 20 year period?

B: Brennan in 1947 did 165.857. In 1970, Bill Falck's winning speed in the Rivets was 231.263 m.p.h.

Q: Had any restrictions on engine modifications or fuel been imposed over the years?

B: Indeed they had. They outlawed alcohol fuel after the 1949 Ontario race, limiting them to regular aviation fuel. They gradually restricted engine modifications so that it is illegal to alter compression ratio, cams, or venturi sizes.

Q: When did the Midget event tie in again with the National Air Races?

B: That was in 1964. After Goodyear dropped them, they had several races in 1950, '51, '52 at places like Ontario, San Diego, Miami, and Newhall. There were none in '53, and then they had a scattering of them wherever they could get together a small purse from 1954 to 1960. There were no races then for four years, and at Reno in 1964 they started on a new cycle in connection with the Reno National Air Races, a cycle that continues right up to the present day.

Q: Are there many of the original Goodyear birds still flying?

B: Quite a few, though considerably modified over the years. The original Shoestring is still going strong – it raced first in 1950. Bill Falck's Rivets is from 1950, and Steve Wittman's Bonzo. Jim Miller's Little Gem of 1950 is now Bob Downey's plane called the Ole Tiger.

Q: What do you think about the kind of replication of the Goodyear event that NMPRA has created and encouraged as Formula I Pylon Racing?

B: Well, I expect you know how I feel about modeling and modelers, and especially about model racing. I think it's not only a tremendously exciting sport in its own right but that the scale aspects of it, and its relation to the history of a great racing event, give it a special kind of prestige and flavor that is hard to find anywhere else in the modeling world.

THE FORMATION OF NMPRA

The first suggestion of R/C pylon racing was at the 1948 Nationals at Olathe, Kansas. The suggestion was made by Keith Storey and Les McBrayer to Walt Schroeder, Bill Winter, and Al Lewis. In 1956 the first set of rules was presented to the AMA rules committee of de Bolt, Bonner, and McKentee, by Keith Storey on behalf of the F.A.S.T. Club. The rules were already being tried out at Sepulveda Basin in Southern California. The first race flown under these rules was won by Howard Bonner.

In 1957 the first AMA pylon event was won by Keith Storey with a semiscale Bonzo. The rules had been modified from the F.A.S.T. Club rules to fit de Bolt's kits. In 1959 there was a meeting of the F.A.S.T. Club at Keith Storey's house after the Nationals, along with Jerry Nelson and Bill Deans. A second meeting several months later finalized rules of 3" x 6" cross-section, cockpit with pilot, .19 engine, 576 square inch wing area.

In 1965, Jerry Nelson, after watching the Reno National Air Races, began to push the idea of forming an organization to revive model pylon racing and to formulate new rules more appropriate to the sophisticated radio equipment then available, and with his leadership the NMPRA came into existence.

RADIO CONTROLLED PYLON RACING IS BORN

by Ed Shipe

Ed Shipe

In 1965 the newly designed event made its debut as an exhibition event at the Nationals at Willow Grove NAS, Philadelphia. In fact, it had only been six months since Joe Martin had won the first race run by the NMPRA at Turlock, California. Proportional control was just coming into general use and old stunt engines were generally the power source for the aircraft. There were only about 17 entries that year with such pioneers of the sport as Ray Downs, Jim Kirkland, Cliff Weirick, Dale Nutter and Maxie Hester heading up the competition. Maurice Woods showed up with a Jim Simpson designed Midget Mustang that he wasn't too sure he could handle so he teamed up with Cliff Weirick to win the event. The event closed with a flyoff between Cliff and Ray Downs with Cliff being held on the line for 17 seconds (so he says) after Ray had taken off. Cliff says he can still hear Ray's caller, Bob Dunham, saying "Here he comes – here he comes" and Cliff finally caught him on the 8th lap at the number 2 pylon to go ahead and win. The Woods/Weirick Mustang was powered by an OS-40 and Ray Down's Shoestring had a howling Johnson up front.

The pylon event was still an after-hours exhibition at the Chicago Nats in 1966, but the entry went up to about thirty. The event was split into a championship bracket and a consolation bracket after qualifying flights were made. Phil Kraft won the championship category after a close race with Jim Kirkland. Maxie Hester won the consolation category with a plane that was the forerunner of the present Formula II event. Goodyear was made an official event following the summer activities and the show was finally underway.

Goodyear made its "official" debut at the '67 Nats in Los Angeles. There were 78 entries and 58 contestants made attempts to qualify for the finals. There were no midairs in this Nats that had five days of racing, and only four planes were lost in the finals – three radio malfunctions and one caused by pilot error. There was one plane lost after the final race of the meet – Cliff Weirick thought he had beaten Joe Foster to win the heat and meet, so in jubilation he made a victory climb that went out of sight straight up – rolled it over and came straight down. The plane didn't pull out and you could have covered the whole wreck with a basket. Joe Foster with his yellow Rivets was the winner with nine wins in nine heats and Cliff was second just two points back.

The year 1968 had Goodyear (later Formula I) as the only official R/C racing event, but the 600 Continentals (later Formula II) made a provisional debut. The Nats were at Olathe NAS, Kansas, with qualifying flights made both on the site and at Tahlequah, Oklahoma. There were 58 entries in the Goodyear event, and Granger Williams was the winner of the rain-shortened event. There wasn't a plane lost in the six-round finals and sub two-minute times had become fairly common. Prototypes were no longer allowed in Goodyear, and as a result there wasn't nearly the delay on the starting line that had been the case in previous meets when prototypes were held on the line for up to 18 seconds after the first plane was flagged off.

The events got their present names and the 600's were made official for '69. Formula I and Formula II became the official classifications as R/C pylon racing came back to Willow Grove NAS. There were 115 entries in the racing events, nearly 100 more than paid the fee just four years before, 65 in Formula I and 50 in Formula II. The rules had been refined over the years, aircraft and engines had been improved and the sport had spread overseas to make it an international event. Yes – R/C pylon had come a long way in the five years of its life.

In '69, the times were getting faster. Jack Hertenstein turned the low scratch time of qualifications at 1:50.2 and eight contestants in Formula I turned scratch times under two minutes. The two minute starting time limit, in which planes were given two minutes to start and then flagged off at 1 second intervals based on handicap (made official in 1970), was agreed to by all contestants. Formula I was it's same old self: Spectacular. Some new names entered the score cards and Larry Leonard won it – with heavy competition from juniors Whit Stockwell and Bob Smith. A flyoff between Whit and Sam Fly for second was a thing of beauty – they came across the finish line so close that you didn't need a blanket, just a postage stamp, to cover them, with the decision going to Sam.

Eighty-two entrants showed up at Glenview NAS outside Chicago in 1970 to compete for the national crown. Times were faster and planes were prettier. The promise shown the preceding year by young Bob Smith was fulfilled when he and caller Jeff Bertken – the B/S Team – took first place after an exciting flyoff with Al Sager, which had to be started twice. Bob turned the fastest time of the meet at 1:36.5.

Back to Glenview in 1971 and this time another youngster, Terry Prather, edged out the veterans with five wins to become the champion, nosing out the Telford/Violett team for first place. Eighty-one contestants paid their money and Paul Benezra from Fresno, California set the pace in qualifying with 1:33.8.

The first international competition was held in 1971 at Doylestown, Pennsylvania. The rules were different as are the planes, engines and name – FAI – but it's pylon racing based on the American concept, and appropriately was won by the American team of Telford/Violett.

Again in Glenview, 1972 was a year for hot engines – and surprises. After eight years, Cliff Weirick returned to the winner's circle with a perfect score. The pre-race favorites had more than their share of troubles and finished out of the money. Bob Smith turned the fastest time of the meet in qualifications with a 1:27.5 and it took a time of 1:40 or better to qualify. Ninety-nine entrants was the new record.

American fliers traveled to England for the FAI races in 1972 and American know-how and experience placed the United States in first with Bob Violett, assisted by Cliff Telford, again bringing home the first place Sopwith Cup.

In the brief span of time since Jerry Nelson, Joe Martin and their cohorts refined the idea of Goodyear racing, the event has come a long way, and the times have plummetted from just over two minutes in 1968 to the low 1:20's in 1972. They founded the NMPRA – National Miniature Pylon Racing Association – to work closely with the Academy of Model Aeronautics in governing racing, setting up rules, contest procedures, and guidelines and to act as a specialized group to gauge the pulse of racing enthusiasts.

The NMPRA has been guided in its evolution by dedicated people, especially the national presidents and district vice presidents. Serving as president have been Cliff Weirick, Ed Shipe, Tom Protheroe, Pete Reed, Bror Faber, and Ed Rankin.

FAI – INTERNATIONAL RACING

by Betty Stream

Betty Stream receives special award for outstanding services to the NMPRA.

Radio control pylon racing, as we see it today, originated in 1965 in the United States, based on the famous "Goodyear" midget racers of the late 40's and early 50's. Formula I is strictly an American sport but from this class was developed a standard international specification which is used all over the world. The models are designed to meet the International FAI category which was first devised in 1969.

As background for the development of this class, all international aviation sporting events fall under the jurisdiction of the FAI (Federation Aeronautique Internationale) which is divided into categories for each aspect of aviation. Activities range from space flight to ballooning; air racing to air education; and naturally all forms of aeromodeling. The modeling category is the CIAM, which in turn is subdivided into interest groups. Thus the Radio Control subdivision handles the rules making and competition for pylon racing.

The AMA pressed for recognition of the FAI pylon racing class for several years, taking an active part in preparation of rules and regulations. The first international contest took place in September, 1971, in Doylestown, Pennsylvania. In 1972, England was the host country for the competition. These events were provisional but the hope is that this class will be given World Championship status in the near future.

The United States won both competitions. Bob Violet, with strong assistance from teammate Cliff Telford, took individual honors.

The models used in FAI competition differ from Formula I planes in several ways; the minimum weight is 2200 grams (4.85 lbs); the model is required to have 45 sq. decimeters (697 sq. inches) combined wing and stab area; a silencer is mandatory on the .40 cubic inch maximum displacement engine; the fuel is 20% oil and 80% methanol (no nitromethane is allowed); and the plane may be modeled after any full-size aircraft that ever raced in competition.

Winner of the FAI pylon racing competition receives the "FAI Pylon Racing Trophy," or "Sopwith Cup," donated by Sir Thomas Sopwith whose name is synonymous with air racing and the pioneer days of aviation.

1971 and 1972 World FAI Champs. Bob Violet (L) and Cliff Telford (R) holding Bobcat FAI Racer with Sopwith Cup.

QUARTER MIDGET PYLON RACING

by John Elliot

John Elliott

Quarter Midgets are a relatively new class of radio controlled racers. The concept originated with Chuck Cunninghorn and others as a class of racing that would be low key and offer some concepts in R/C racing different from those of Formula I, II, and FAI

Some of the ideas were to emphasize smaller, less expensive engines in stock form, stock props, fuels, and accessories easily obtained by modelers everywhere; and encourage a wider variety of scale-like models to compete.

By formulating a set of rules that placed little emphasis on the engine "specialist" or the fuel "chemist," this placed major emphasis on the ability to be consistent in preparation and flying.

The rules permit a model of any aircraft that has flown closed course events, raced cross country, or flown straightaway record attempts, to be eligible for QM racing.

The latitude allowed in design selection has brought out, along with the usual P-51 Mustangs and Minnows (both very popular designs) such types as Bearcats, BF-109's, Sea Furys, P-40's, Fire Crackers, Sweet-peas and Petes. When you go down through the "golden era" of air racing, when you recall the World War II war birds that have been converted to unlimited racers, and when you research some of the beautiful full size Formula I ships built since the late 40's, its obvious that the quarter midget designer will never run out of subjects to design and race.

Anybody for a Gee Bee R-1?

The rules are basically simple with respect to model limitations. Wing area shall not be less than 300 sq. in., the model must weigh between 2-1/2 lbs. and 3-1/2 lbs., meet specified dimensions in the fuselage height and width, and other general specifications.

Last, but not least, and felt by many to hold the key to the future growth of QM racing, are specific requirements regarding the ability of the engine to idle reliably either before or after completion of a heat race, or both at the discretion of the contest director. Failure of an engine to idle a specified period of time before a heat race results in no score for that heat. If the engine quits after a heat race or before touch down, loss of some points from the pilot's finishing order is the result.

In many of the races held thus far, the fastest plane and pilot have not always been the winner. Consistency has many times been the deciding factor. Newcomers to R/C modeling and to racing in particular are quite surprised to discover the performance and speed these .15 powered semi-scale models exhibit.

A fair amount of speed, the challenge of a duel for the checkered flag, the satisfaction of "racing" planes rounding the pylons in close company are just as much a part of quarter midgets as they are the "big uns."

Go Fast and Turn Left!!!

Jack Stafford's P-51 Mustang Quarter Midget racer painted with Jack's favorite red, white, and blue paint scheme.

TURN – WHAT IT'S ALL ABOUT

by Bob Stockwell

What's happening? Miniature aircraft are RACING . . . At speeds up to 150 miles per hour . . . With engines turning up to 20,000 r.p.m. . . . Their pilots have lightning reflexes . . . or dead airplanes . . .

The pilots enjoy . . . The excitement of racing . . . The tension of competition . . . The satisfaction of fine hand craftmanship . . .

And sometimes they endure . . . The agony of crashes . . . from midair collisions . . . from dumb thumbs . . . And sometimes . . . They just get too close to the ground . . . like six inches below the surface . . . and no one knows why . . .

Out there between the pylons are fliers . . . the ones holding transmitters with antennas . . . their hands shaking . . . their throats tight . . . their knees like rubber . . .

Circling around the fliers are callers . . . who tell the fliers when to turn . . . and whether they're ahead or behind . . . and console them when they lose . . . and pick up the pieces when they crash . . . and get none of the credit when they win . . . but all of the blame if they lose . . .

At the pylons and starting line are race officials . . . dedicating time and boundless energy . . . counting laps and keeping the times . . . watching for cuts, keeping the game fair . . . hardly noticed till things go wrong . . . always working, all indispensable . . .

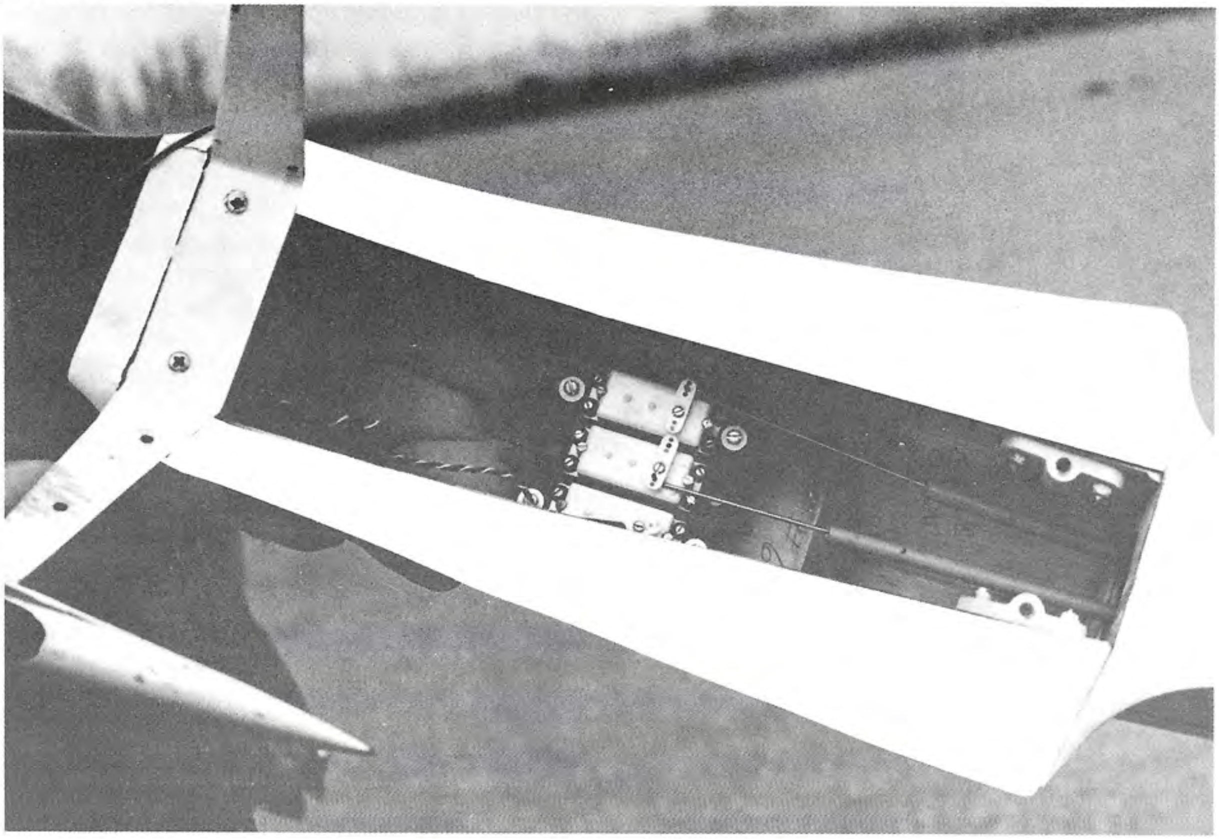
What controls the airplane? . . . The headbone's connected to the neckbone: The neckbone's connected to the armbone: The armbone's connected to the thumbone: The thumbone's connected . . . loosely . . . To the transmitter sticks: The sticks control the receiver . . . up there in the airplane . . . It controls tiny motors . . . called servos . . . And they control the elevator (. . . up or down . . .), The rudder and ailerons (. . . right or left . . .) (. . . mostly left . . .)

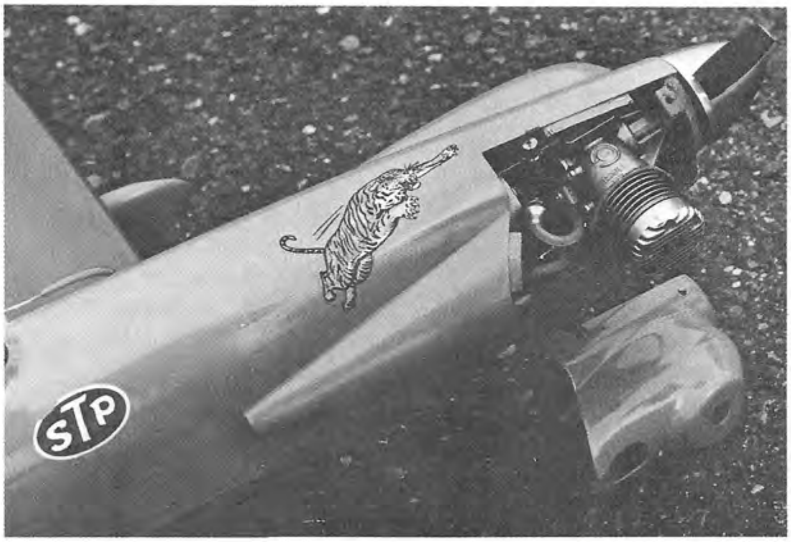
And when it all works . . . the little bird flies . . . just like the big ones!

TRANSMITTER

This is the remote control unit, the transmitter. The pilot operates two sticks (sometimes combined into a single stick unit). These sticks operate the control surfaces, like the stick and rudder pedals of full-sized aircraft, by activating servo motors shown in the model below.

AIRBORNE CONTROL EQUIPMENT





ENGINE COMPARTMENT

Here is the front end of a model with the cowling removed. The engine revs up to 20,000 RPM. For those with a technical bent, it is a two-cycle glow-plug engine displacing .40 cubic inches using fuel containing mainly alcohol, nitromethane and castor oil.

WORKMANSHIP

The starting order is determined by quality of workmanship, by accuracy of scale outline (these are semi-scale models of full-sized aircraft), by degree of detailing and excellence of finish. The best finishes shine like mirrors – here you can see a modeler's face reflected in the gloss of his wing.

STARTING LINE

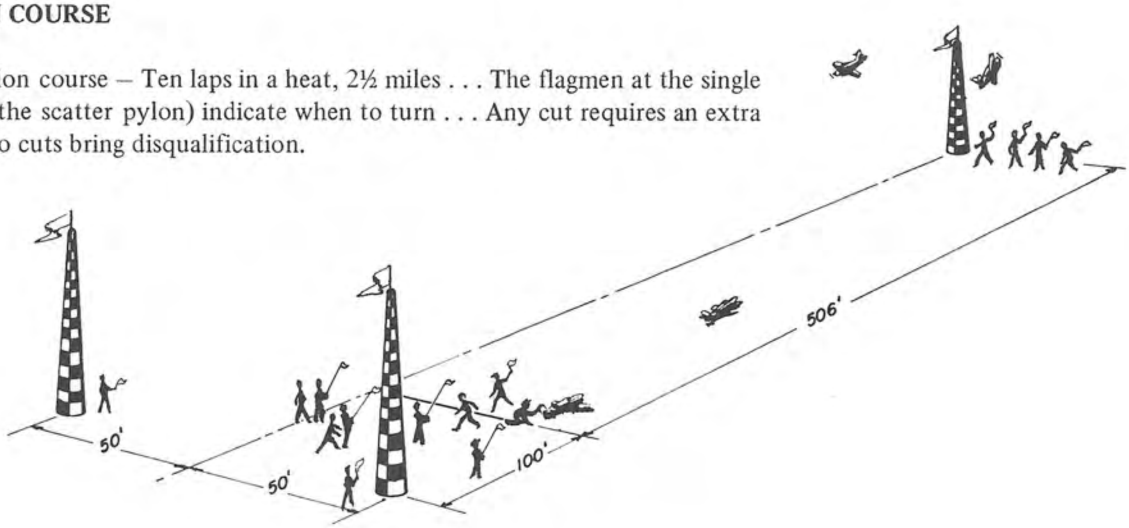
The starter drops his flag. The caller releases the plane before running back to guide his pilot through the turns. The planes in the heat take off at one-second intervals to avoid collisions at the start of the race.

PILOT AND CALLER

A pilot with his transmitter, his caller ready to yell "Turn"! It is the job of the caller to keep the pilot on his course, tell him when to go up or down to avoid possible collisions, and keep track of his position in the race.

PYLON COURSE

The pylon course – Ten laps in a heat, 2½ miles . . . The flagmen at the single pylon (the scatter pylon) indicate when to turn . . . Any cut requires an extra lap. Two cuts bring disqualification.



PILOT AND TROPHY

The name of the game in racing is to go fast under control. The sport encourages the best in craftsmanship, in flying skill, and in sportsmanship. The winner here with his plane and trophy shows what it's all about: the satisfaction of a hard-earned victory!

GETTING STARTED IN RADIO CONTROLLED PYLON RACING

by Bob Upton

Bob Upton

The sport of R/C pylon racing differs from everyday Sunday flying in many respects. For example, the average .60-powered R/C sport stunt model carries around 700 sq. in. of wing area, weighs six to seven pounds, and is driven around the sky by a four-to-six channel proportional radio. The engine will turn an 11-8 prop between 10,000 and 14,000 rpm on regular sport fuel (8 to 15% Nitro) and the model will fly flat out at between 75 and 85 mph.

A Formula I racing model, on the other hand, powered by a .40 cu. in. engine, carries 450 sq. in. of wing area, weighs five pounds, and is driven around the sky by a four channel proportional radio. Here, however, the simularity ends between the stunt machine and a thoroughbred Formula I racer.

Speed is the name of the game and it increases with meticulous attention to the smallest detail learned through observation of others and through experience. Today's racing 40's turn to 20,000 rpm on fuel that contains, among other ingredients, from 50 to 70+% nitromethane. These engines have increased the straightaway speed of a Formula I racer to around 150–175 MPH!! When a model airplane is travelling at this speed and is required to negotiate a maximum G turn in the shortest possible radius, it had better be built to withstand tremendous strain in the interest of safety to bystanders or spectators, as well as keeping the equipment in one piece! In addition, the model becomes much more critical to flutter modes as the speed increases. Greater care and attention to detail are therefore demanded when installing the control surfaces, etc. The wing should be liberally reinforced in the center section to prevent folding of the wing in a maximum G turn. (More about this later.) The engine must be anchored very rigidly within the model to obtain maximum power from it; engine vibration alone, tearing the engine from its mount, has been the downfall of many a modeler. Push-rods, servo rails, control horns – all have to be carefully constructed and installed to minimize the possibility of failure at the speed at which the racer moves through the air.

The critical factors just outlined with regard to successful R/C racing are much less a problem to the stunt model of the Sunday flier simply because the model is not operating in the same region as a Formula I racer, although attention to detail is important, no matter what phase of the R/C world you are participating in. But meticulous attention to details becomes increasingly important as the speed of a model increases. The following discussion is an attempt to help those new to the racing game.

Whether it be for Formula I or FAI, start with an established racer that is known to be a good, consistent flying model. You need only to attend the next race to determine which model flies well and is leading the pack.

The key elements in framing a racing model are strength and lightness. Bear in mind the tremendous horsepower today's racing engines develop and the attendant vibration your airframe and radio are going to be subjected to. The areas that demand particular attention are the following: In the engine compartment, make sure the firewall is at least 1/4 inch thick, of a good grade of plywood (5 ply), and is *very* securely cemented and epoxied in place. Back-up gussets are a good idea here. When attaching the engine mount to the firewall, use 6/32 screws with lock washers and put them in *tightly*. You would be surprised how easily an engine mount can come loose when your engine is turning between 18,000 and 20,000 rpm. Vibration problems rob your engine of rpm and seriously hamper the operation of your radio. Therefore, it is extremely important to balance your *props* and *spinners* prior to use.

The balsa wood sheeting should be at least 3/32 inch thick on foam wing cores, and a good grade of adhesive used to attach the skins to the wing. A word of caution: don't sand the wing skins down too thin, as this material is the ultimate strength of the wing. Use glass cloth or celastic *generously* in the center section. The greatest stress is in this area. The next time you attend a Formula I contest, notice how the wings flex as the models negotiate a tight pylon turn. This observation will make a believer out of you about the necessity for a rugged framework.

Fairly sharp leading and trailing edges on the flying surfaces are essential for good penetration and speed.

The stabilizer should be of fairly hard stock and should be at least 1/4 inch thick. Again, don't sand the stab too thin, as you could run into a flutter problem, resulting in a bent bird.

Proper hinging of the flying surfaces is very important. It is a good idea to epoxy toothpicks through every hinge anchor. If you have a fairly long moving surface, such as an aileron on a Minnow, for example, use three hinges per aileron. The more rigidly the control surfaces are mounted to their respective components, the less likely a flutter problem will develop.

Speaking of control surfaces on most Formula I or FAI models, very little travel is required to obtain a very positive and quick reaction. The aileron travel should not exceed 3/8 of an inch in total up-and-down deflection. In most cases, 1/4 inch is sufficient. The elevators need not travel more than five degrees up or down. Of course, the sensitivity of the controls is up to the individual flier. However, please bear in mind that an over-sensitive model will be a "ball of snakes" during "up-tight" competitive flying, particularly if the flier is new to racing. Chasing around in the sky solo with a racer is one thing, and flying in a race against your peers is quite another thing, indeed!

While on the subject of flying, competitive racing is *not* a sport for the novice R/C flyer. I'm afraid there is a misconception in some circles that pylon flying is easy. After all, "you just go around in circles!" Nothing could be further from the truth: learning to fly a good course around the pylons is an art acquired only through constant practice and participation in the various racing events.

Most racing models require a lot of room to land and are a bit trickier in general to handle. Since, out of necessity, the model must be flown fairly close to the ground, there is not much margin for error, particularly at the speeds the models fly. While we don't wish to discourage newcomers to the racing game, we do recommend considerable stick time prior to attempting to compete against the "fast guys."

Since the name of the game is speed and speed equals essentially engine plus consistency, we will dwell on these subjects. Your choice of engine should be dictated by the competition. Look around and pick an engine you think you can live with and unless you are an expert, leave the engine work to the experts. Engine rework is found elsewhere in this text. However, the engine setup is extremely important and merits considerable attention. In some cases, the carburetion should have a forced-air system connected to it when a pressure system is used. In rear rotor engine installations, a hole larger than the carburetor barrel intake is drilled through the motor mount and the firewall, in line with the barrel, and a channel leading from the hole to the empty cheek cowl (the cowl opposite the engine cowl) is constructed on the back side of the firewall. An air intake opening is provided in the front of the cheek cowl leading to the air chamber behind the firewall. No exhaust hole is provided in the empty cheek cowl, so that air is forced into the carburetor barrel through the channel communicating with the inside of the cowl, thence into the carburetor.

Next, the removable cowl surrounding the engine should have a cooling slot in the front, approximately 1/4 inch wide and 5/8 to 3/4 of an inch long, and an exhaust outlet to the rear of the engine at least triple the size of the front opening. A baffle should be placed behind the engine to direct the air out of the cowl through the exhaust opening. A short stack extension may be used to direct the engine exhaust out the cheek cowl.

The fuel tank should be a minimum of eight ounces, since today's racing engines consume increasing amounts of fuel as the horsepower curve goes up. I use a ten-ounce metal tank. The fuel pickup should be fixed inside the tank towards the lower right-hand corner of the tank. The fixed pickup allows the flyer to invert his model to shut off the engine in the event the engine shut-off fails. If a plastic tank is used, it should be reinforced on the outside to resist the pressure from the engine pressure pickup. The pressure line within the tank should be at the top front of the tank.

When a two-line (fuel pickup and pressure line) system is used, it is necessary to disconnect both the fuel line and the pressure line to the engine in order to fill the tank. An alternative method is to use two additional vent tubes leading to the top front of a metal tank for fueling purposes. After filling the tank, merely bridge the two vents with a length of fuel line. This procedure leaves the fuel line and pressure line permanently connected to the engine and a length of safety wire around these lines to their respective nipples is an added precaution. A small hole in a fuel or pressure line will result in an extremely erratic engine run, and for this reason, it is best not to disturb these vital connections.

The next and final point to make is consistency. Strive for *consistency!* Preventive maintenance will go a long way towards your goal of consistency. When on the starting line, your engine should start every time without trouble. After a race, the first thing that should be done is to refuel the model. Make a visual check at this time of the fuel lines, prop, and engine compartment, making sure everything is in order. Next, remove the plug from the engine and replace as necessary. Most fliers use a no-idle-bar plug for best results. Finally, check the wheel alignment. Oftentimes a moderately rough landing will "spread eagle" your gear which can easily cause an embarrassing nose-over your next time at the starting line.

As to flying the pylon circuit, only experience and a good caller will bring in a winner. However, a well-constructed model with a proven engine installation will go a long way towards helping you reach your goal of becoming a winner, as well as providing a sound platform for building confidence in the flier. The next time you are at a racing event, don't be afraid to ask questions; most modelers, if they are not particularly pressed, will be glad to help you. See you at the next race!

Formula I Racer on the starting line ready for take-off

Kent Nogy, with record 1:22.1 set at Mile Square on May 6, 1973. Kent also held 1972 record speed of 1:23.4.

Hale Wallace's DeKnight Special at 1969 Nationals.

Ed Rankin on EK-logictrol

"There are several elements required to be competitive in R/C Pylon Racing, and one of the most important is the selection of a reliable radio control system. The radio system must function with a low failure rate in an environment much more severe than any other event due to the high vibration level and high servo loads. In addition, it is very important that the servo response rate be very high and that servo centering be very accurate.

"I have selected the EK-logictrol Radio Control System because it fulfills all of these requirements. I have been using this radio in my Pylon Racers since 1968 and have lost only two airplanes due to radio failure, which is a fantastic record. These crashes were due to servo failure caused by a dead spot in the motor brought about by prolonged usage.

"I can highly recommend this radio system to you as a reliable element in your Pylon Racer. In addition, when repair is required, EK Products has the best service department in the industry and can repair your radio promptly."

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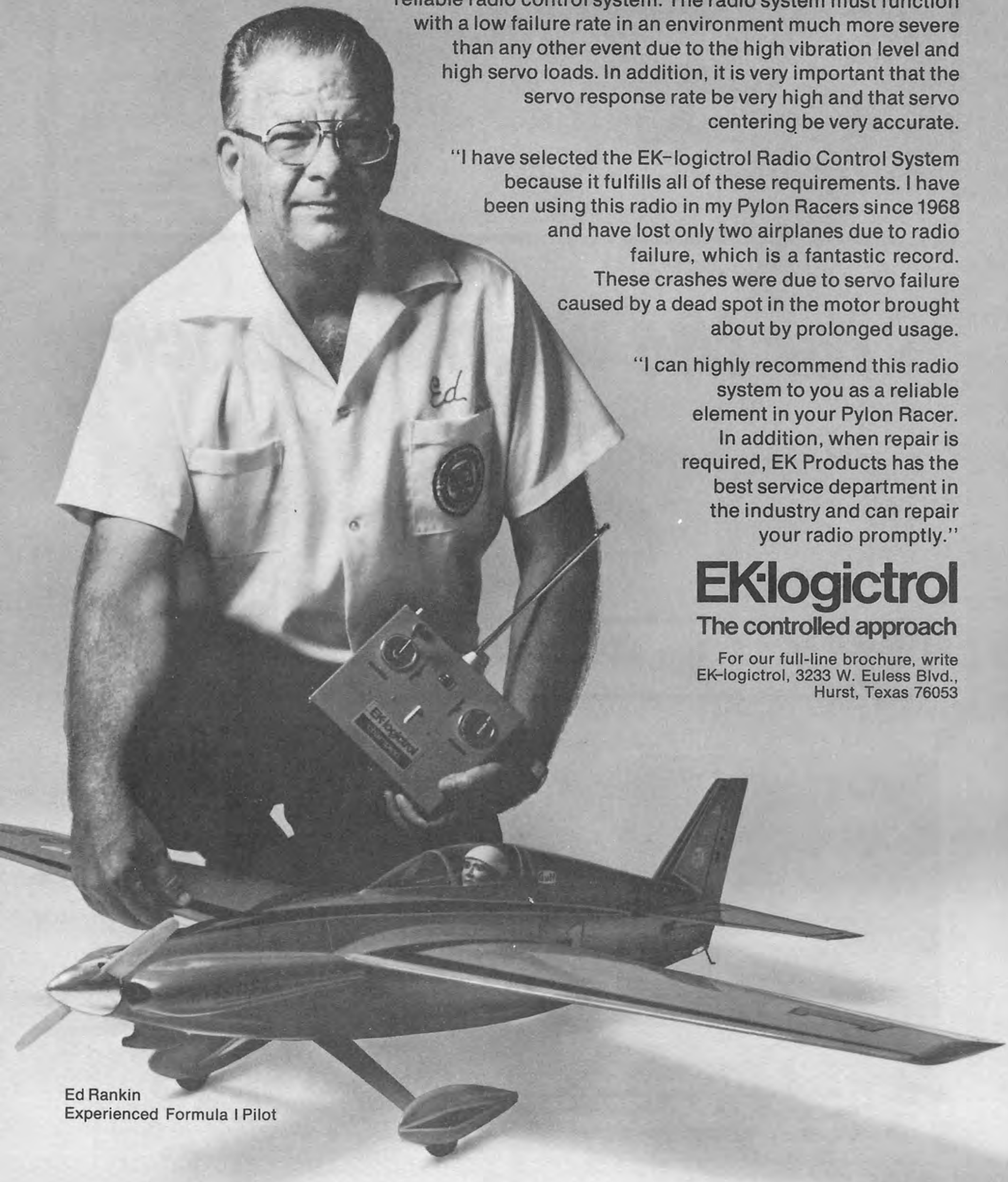
The controlled approach

For our full-line brochure, write EK-logictrol, 3233 W. Euless Blvd., Hurst, Texas 76053



Ed Rankin
Experienced Formula I Pilot

STABILITY AND CONTROL

by Ed. E. Rankin

Ed. E. Rankin

Several factors contribute to a stable flying Formula I racer with good handling qualities, and it is very important that they be chosen properly. These factors have an interaction on each other and are as follows: (1) horizontal and vertical tail area and location, (2) balance location, (3) control surface area and travel, and (4) wing dihedral. Normally for a full sized airplane these elements are chosen from exhaustive wind tunnel tests and from elaborate technical calculations. However, wind tunnel test data is usually not available for a model, and well established "rules of thumb" can be followed which will be discussed here. As a general rule for the racing model, a relatively forward center of gravity location and small control surface areas and travels are required.

The aerodynamic center of the wing must first be located before the tail surface sizes can be chosen. The aerodynamic center of a surface (a.c.) is the point at which the resultant lift of the surface is assumed to act. The location of the a.c. is expressed in terms of percent of the mean aerodynamic chord of that lifting surface. Figure 1 shows a geometric and analytical solution of determining the mean aerodynamic chord ($\bar{c}$) for the wing which can also be used for the tails. For most airfoil shapes the a.c. will be located at approximately $.25\bar{c}$ for subsonic speeds.

Having determined the a.c. of the wing, the horizontal and vertical tail surface areas and location can be chosen. These surface areas can be selected by the use of well known tail volume coefficients ($\bar{V}$) that work for a racing model and are shown in equations (1) and (2). For a full sized airplane, these surface sizes and locations are usually selected from thorough but relatively complicated analytical techniques. These techniques consider wing, tail, and thrust contributions; fuselage effects; wing downwash effects; and propeller slipstream effects which are very hard to determine for a model. The $\bar{V}$ is an important quantity in these considerations and provides a good indication of how to size the tails and where to locate them in respect to the wing.

Equation (1): $$\bar{V}_{HT} = \frac{L}{\bar{c}} \times \frac{S_{HT}}{S_w} = .35 \text{ to } .45$$

Equation (2): $$\bar{V}_{VT} = \frac{L}{b} \times \frac{S_{VT}}{S_w} = .025 \text{ to } .035$$

Where:

- L = distance between $\bar{c}/4$ of the wing and tail surface (inches)
- $\bar{c}$ = mean aerodynamic chord of wing (inches)
- b = wing span (inches)
- S_{HT} = horizontal tail area (square inches)
- S_{VT} = vertical tail area (square inches)
- S_w = wing area (square inches)

The following tail area relationships should be used for racing model:

Equation (3): $S_{HT} = .18 \text{ to } .23\ S_w$

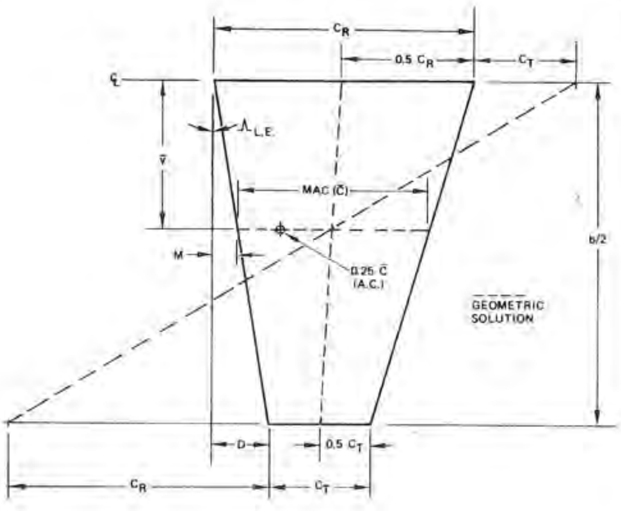
Equation (4): $S_{VT} = .05 \text{ to } .08\ S_w$

Substituting equations (3) and (4) in equation (1) and (2) respectively, the tail arm (L) can be calculated, thus locating the tails. The tail areas and tail arms can be varied in equations (1) and (2). However, it is not recommended to select a tail arm for the horizontal tail less than $2 \times \bar{c}$. Selection of the higher value for $\bar{V}$ and tail areas will give a more stable model, and selection of the lower values will give less stability.

The balance location can now be chosen upon completion of tail sizing and location. For a good stable flying Formula I racer the center of gravity should be located between $.20\bar{c}$ and $.25\bar{c}$ of the wing as shown in Figure 2. This c.g. location is considerably forward of that recommended for a pattern model. The high rate of speed and consequent high response to control inputs results in a desire for reduced sensitivity. Another factor that tends to increase the control sensitivity of a racer is the fact that the horizontal tail is not as effective as that of a pattern airplane which causes the total airplane a.c. to be further forward. This is due to the shorter tail arm and the associated downwash effects from the wing. Another factor is the longitudinal destabilizing effects of the long nose and large cheek cowls on the fuselage.

Small control surface areas and travels should be selected for the racer, especially the elevator and aileron, because of the high response to control deflections. The rudder area and travel is not critical since it is only used during takeoff and landing. The following surface areas and travels are "rules of thumb," and the lower value should be selected if the c.g. is further aft than $.20\bar{c}$.

SURFACE	AREA	HINGE LINE	TRAVEL
Elevator	.30 to .35 S_{HT}	.25 to .30 $\bar{c}$	$\pm 5^{\circ}$ to $\pm 7^{\circ}$
Aileron (Conv.)	.05 to .06 S_W	.10 to .15 $\bar{c}$	$\pm 5^{\circ}$ to $\pm 7^{\circ}$
(Strip)	.05 to .06 S_W	.05 to .07 $\bar{c}$	$\pm 3^{\circ}$ to $\pm 5^{\circ}$
Rudder	.25 to .30 S_{VT}	.25 to .30 $\bar{c}$	$\pm 10^{\circ}$ to $\pm 15^{\circ}$



ANALYTICAL SOLUTION

$$S_W = \left(\frac{C_R + C_T}{2}\right) b \qquad \bar{C} = 2/3\, C_R\left(1 + \lambda - \frac{\lambda}{1+\lambda}\right)$$

$$b = \sqrt{AR \times S_W} \qquad \bar{Y} = b/6\left(\frac{1+2\lambda}{1+\lambda}\right)$$

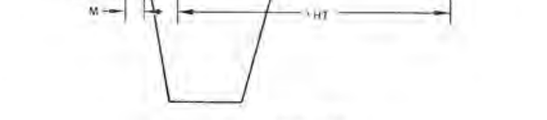
$$C_R = \frac{2\, S_W}{(1+\lambda)\,(b)} \qquad D = b/2\,(\tan \Lambda_{L.E.})$$

$$\lambda = \frac{C_T}{C_R} \qquad M = D/3\left(\frac{1+2\lambda}{1+\lambda}\right)$$

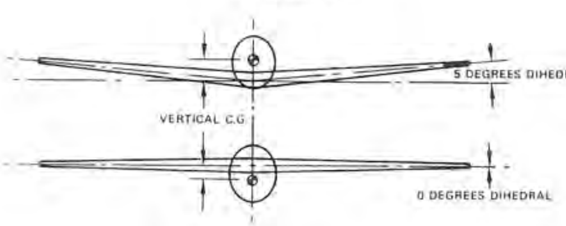
A.C. LOCATION
FIGURE 1

Another important factor for a stable flying racer is the selection of wing dihedral and wing location with respect to the fuselage. For low wing racers, a dihedral of at least 5° to 6° should be used, and a dihedral of 0° can be used for the mid wing racer as shown in Figure 3. The low wing model usually has a high vertical c.g. location, and wing dehedral is required to give good lateral stability in the turns. For the mid wing racer no dihedral is required since the vertical c.g. is below the wing giving an inherent lateral stability in the turns.

In conclusion, if these guidelines are followed, the Formula I racer will usually be very stable and can be controlled very smoothly. However, if c.g. locations and surface travels are selected that are similar to the pattern model, you will have a "tiger by the tail." Usually, the racer must be test flown to determine if the handling qualities suit the individual pilot. Minor corrections can then be made in the c.g. location and surface travels to compensate for the "unknowns" in design characteristics. If the racer hunts in the longitudinal axis, and will not "groove," then the c.g. is too far aft for the tail size and location. To correct this move the c.g. forward. If the racer "craw-fishes" (tail wiggles) in the directional axis under high wind conditions, the vertical tail is too large. To correct this reduce the vertical tail size proportionately in the chord and span to preserve the AR. Lastly, when designing the wing and tails it is advisable to keep the AR as high as possible to make the surface more effective.



C.G. LOCATION
FIGURE 2



DIHEDRAL ANGLE
FIGURE 3

WINGS: THEORY AND PRACTICE

by Jack Fabbri

Jack Fabbri

WINGS – This section will discuss briefly some types and characteristics of wings, how they work in general and some construction techniques. No attempt will be made to explain in technical terms the intricate details of aerodynamics.

Let us first agree that the primary function of the wing is to keep the airplane in the air. This is accomplished by driving the wing through the air at a speed and angle of attack such that the lift characteristics of the wing equal the weight of the aircraft. The energy to drive the vehicle through the air is provided by either an engine or gravity (the latter in the case of sailplanes).

How we select a wing depends on just what characteristics one wants besides its primary function, i.e., – Lift a lot of weight – Go fast – Go slow – Turn tight – Stall abruptly – Stall gently – Glide well – Sink like an anchor – Handle a lot of horsepower – Fly on very little power – etc. . . .

As can be seen from the above partial list, this article could go on for volumes; however, things can be generalized into a list of certain characteristics that more or less come off the shelf with certain wing designs.

LIFT – Now let's look at that primary function. Bernoulli will tell you that the same phenomenon that makes a carburetor or venturi suck fuel out of the tank makes the wing fly. That is, as air molecules are accelerated over a surface, the pressure they exert against that surface decreases. Naturally, if the wing is to lift up, the air must accelerate to a higher speed on top of the wing than it does below the wing. This is accomplished by the shape and angle of attack (the angle at which the wing meets the air in the direction of flight of the aircraft–Fig. I). Though Bernoulli is in essence accurate in his theory of velocity and pressure, there is more to keeping a wing in the air than that. Consider Newton's Law that for each action there is an equal and opposite reaction. A force (air) is acting on the wing to keep it up, therefore an equal and opposite force is acting on the air below the wing, thus tending to push this air down. Maybe that's why paper gliders fly.

AIR – Let's consider some of the properties of air before going further Air has density* and therefore weight and inertia. It has viscosity** and behaves just like other viscous fluids (such as molasses) inasmuch as one can change its shape, cut it apart and it will return to its original form, without suffering permanent damage once left alone. Like other gasses it is compressible and its temperature is variable with pressure.

DOWNWASH – Recalling, now, the paragraph preceding the above, it was stated that the force to hold the wing up was opposed by an equal force pushing the air down. This is the cause of the downwash behind the wing. The inertia of the air being pushed down under the wing keeps the air moving down after the wing has passed. The viscosity of the air and the pressure of the free air stream eventually stops this and puts the displaced air back where it was with respect to the free air prior to when the wing moved it around. It should be clear that the airflow coming off of the top of the wing will, due to pressure, follow the wash.

AIRFLOW AROUND THE WING – Consider, for this description, that the airflow is made up of molecular adjacent layers parallel to the direction of flight of the airfoil (Fig. II). Let's follow one molecule as it is forced over the wing (Fig. III). In Figure III, A represents the molecule in free state, B is the point of contact with the wing leading edge. At point B the molecule has zero speed with respect to the wing and is exerting its greatest force against the wing. The molecule accelerates from zero to its highest speed relative to the wing from point B to

*Density 1.293×10^{-3} grams per CM^2 or .07323 Lb/Ft^2 (Eshbach)

**Viscosity 181.2×10^{-6} poises (Dyne per CM^2)

Both of the above vary with pressure and temperature.

point C where it exerts the least force against the wing. From point C to point D the molecule then decelerates to zero relative speed at point D where it then exerts the same pressure on the wing as it did at point A. Our molecule's immediate neighbor below did the same thing under the wing; however, due to the shape (or angle of attack or both) of the wing, it did not have to travel so far (otherwise the wing would not be lifting – angle of Zero Lift, that angle where the pressure above the wing is equal to the pressure below the wing).

BOUNDARY LAYER EFFECT – Figure III and the above paragraph dealt with the airflow over the wing in a much simplified manner. A phenomenon called Boundary Layer Effect somewhat complicates life for our air molecule described above. This Boundary Layer Effect is a characteristic that comes with viscous mediums. It can be descriptively defined by stating that the layer of air immediately in contact with the wing has almost zero airspeed with respect to the wing (that is it's nearly not moving past the wing) and that each adjacent layer of air slips a little until the normal air stream is encountered. The thickness of the boundary layer is dependent on the viscosity, the density of the medium and the speed at which it is moving relative to the penetrating vehicle (wing in this case). Suffice it to say that in the realm of model aircraft, the boundary layer is quite thin (only a few thousandths of an inch thick). Figure IV shows graphically the effect of boundary layer, the line L, being the relative position of a vertical column of air molecules after the wing has penetrated.

REYNOLDS NUMBER (Re)* – An often used, seldom understood term in modeling which is a numerical statement indicating the ratio of inertial forces of a fluid to the viscous forces of the fluid. Reynolds Number is dependent on the density and viscosity of the fluid and the length and speed of the body passing through it. At high Reynolds Numbers the effects of viscosity are quite trivial, but at the relatively low Reynolds Numbers (approximately 1/2 million) found in model aircraft flight, the viscous forces of air cause wings to behave a little differently than the tables for full size aircraft might indicate, the primary difference being that the model wings are nowhere nearly as efficient as are the big ones.

LAMINAR FLOW VS TURBULENT FLOW – This subject is black and blue from being kicked around in the racing circuits and is really overworked when it comes to modeling. Briefly, flow is said to be laminar when it flows smoothly over the leading and trailing edge of the wing (Fig. V) and is considered turbulent if it separates from the airfoil contour before leaving the trailing edge (Fig. VI). These flows are quite dependent on Reynolds Number, and in the size and speed range of model aircraft (yeh, even the 150 mph Formula I machines) the airflow is usually laminar at level flight over most any airfoil! The real argument about the laminar or "trick" wings is just exactly when the laminar flow separates and becomes turbulent. That is, at what combination of speed, angle of attack and wing loading does this happen; it *does* or the wing won't stall (more will be said about stall later on). Suffice it to say that a wing can be shaped to cause the laminar flow characteristics to remain for higher speed, wing loadings and angles of attack than would otherwise occur for some conventional wing shapes. But beware, the higher the loading and angle of attack of a wing when laminar separation occurs, the more violent (and usually permanent) will be the results! It is also a fact that the "laminar or trick" wings are quite critical and require a lot more attention (and talent) to fly than do some of the more conventional airfoils.

STALL – Stall occurs when the airflow passing over the leading edge of the wing is forced back toward the leading edge (Fig. VII). This happens when the pressure behind the wing's center of lift is greater than that ahead of the center of lift, and therefore overcomes the inertia of the airflow. The cause of this pressure configuration is normally excessive angle of attack for the wing loading and airspeed of the model. Realize, of course, that other factors influence the flow reversal, such as the viscosity of the adjacent layers of airflow, due to boundary layer effect, the cleanliness of the wing surface, temperature, etc.

AIRFOILS – There are basically two types of airfoils: symmetrical and non-symmetrical.

Symmetrical Airfoils: A symmetrical airfoil is one in which the manufacturing chord plane is flat, that is, if a line was to be drawn through any combination of 1/2 thicknesses from the LE to the TE the line would be a straight line. Symmetrical wings create no lift at zero angle of attack. They impose no pitch moment, regardless of speed, to the aircraft. A symmetrical wing requires an angle of attack to create lift (Fig. VIII).

Non-Symmetrical (Cambered) Airfoils: A non-symmetrical wing is one in which the manufacturing chord plane is not straight, that is, the line drawn through the 1/2 thicknesses from LE to TE is a curved line. A wing by this definition is considered cambered even when the lower surface is not concave

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*$Re = \frac{pVL}{\mu}$ where p = density, V = velocity, L = length (chord) and μ = viscosity. This formula is adequate though not 100% accurate in all cases.

or flat. Non-symmetrical (cambered) wings create lift at zero angle of attack. They impose a pitch moment to the aircraft as it flies. This pitch moment is due to a higher upper surface pressure at the leading edge than at the trailing edge (assuming the wing is right-side up).

CHARACTERISTICS OF AIRFOILS AND WINGS – There are countless numbers of publications available which catalog the shape and performance curves of various airfoils. The following is intended only as a general idea of where to start in selecting a wing configuration.

SYMMETRICAL AIRFOILS – These have been around modeling since the beginning and are probably the most widely used type of airfoil in the hobby. As previously stated, these airfoils require an angle of attack to create lift and they have no pitch influence of their own. They have in general the following peculiarities:

a. They fly the same inverted as they do right-side up. An aircraft with such a wing installed with zero incidence must furnish the angle of attack to fly, up elevator right-side up, the equivalent down elevator inverted. An aircraft with this type of wing at 0^{o} incidence and having the thrust line and stabilizer also at 0^{o} tends to hunt for level (porpoises) when the airplane is properly balanced. This is due to the lack of positive (or negative) stabilizer loading. Many aircraft using symmetrical wings are set up with positive wing incidence and negative (down) thrust to off-set the tendency to climb as power is increased. This works, of course, but the engine, wing and elevator are all working against each other to keep pitch equilibrium and therefore the trim drag envelope is increased. In addition, the offsetting thrust and incidence configurations require considerable down elevator when inverted.

b. They tend to slow down considerably in tight turns due to induced drag buildup (the full size sport bi-plane and racing guys have the same problem).

c. They are quite suitable for those designs where a narrow speed envelope is desired when built with relatively thick chords (15% and up). Many of the leading pattern flyers prefer an airplane with a narrow speed range because it is easier to time and predict a near constant speed aircraft than it is for one which, for example, climbs up a top hat at 35 mph and comes back down the other side at 95 mph.

d. In a specialty use, such as racing, these wings can be made to go reasonably well with medium to thin chord thicknesses and relatively aft maximum thicknesses (i.e., the ever-popular laminar shapes). In this form, they still have some slowing tendency in tight turns and they have some rather unique stall characteristics (which usually return the airplane to kit-form). This use of the symmetrical section truly takes a smooth pilot who flies the aircraft around turns rather than yanks it around and who also knows just where the ragged edge of the wing is.

e. As in most cases, the thicker the airfoil section is, within reason, and the rounder the leading edge is, the higher will be the angle of attack when stall occurs. This is good for pattern, but not necessarily good for scale or racing. A thin airfoil will stall sooner, more gently, and usually will recover quicker.

CAMBERED AIRFOILS – The non-symmetrical airfoils have some distinct advantages and disadvantages over the symmetrical shapes. As previously mentioned, they do induce lift at 0^{o} (or less) angle of attack and they do impose a pitch moment. Excepting the "laminar symmetricals" this type of airfoil is very popular in the racing field. Some pattern aircraft also use the cambered wings for their speed, flexibility and inverted flight advantages which can be achieved. The following seem to apply to this type of wing:

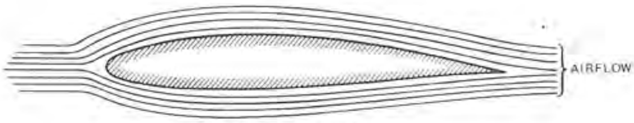
a. They produce lift at zero angle of attack. Since this is the cleanest presentation of the airfoil to the airstream, some drag reduction over symmetrical wings is gained. The wing section and thickness, of course, must be engineered to the speed and load of the aircraft; if not, these type of wings will hurt rather than help.

b. The fact that a cambered wing produces a pitch (down) moment allows a zero-zero airplane to maintain a definite (but small) negative tail loading. This greatly reduces the porpoise effect at level flight.

c. This type of airfoil is usually capable of greater speed envelopes than is its symmetrical counterpart. Thickness tends to be more limiting at high speed on this type of airfoil. However, the thinner these sections are built, the faster they tend to go, but beware: when the top end of the speed range is raised, so goes the lower end!

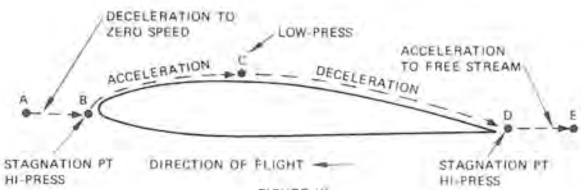
d. There is a built-in trim advantage to a properly selected non-symmetrical airfoil. For example, if the upper surface high point is 40% and the lower is 30%, the center of pressure (center of lift) of the wing will shift forward relative to the airplane CG when the airplane is inverted. This definitely helps keep the nose up when inverted without having to carry much down elevator. Properly done, an airplane with the right non-symmetrical wing will roll, on axis, without elevator correction.

FIGURE I



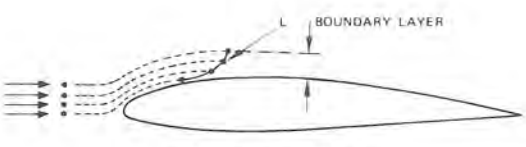
DIRECTION OF FLIGHT ←

FIGURE II



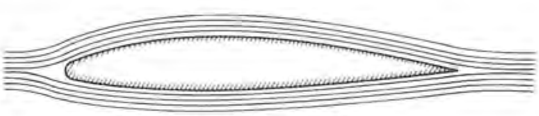
DIRECTION OF FLIGHT ←

FIGURE III



DIRECTION OF FLIGHT ←

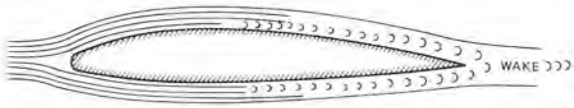
FIGURE IV



DIRECTION OF FLIGHT ←

LAMINAR FLOW

FIGURE V



DIRECTION OF FLIGHT ←

TURBULENT FLOW

FIGURE VI

FIGURE VII

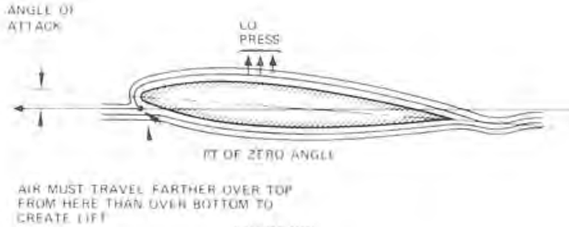


FIGURE VIII

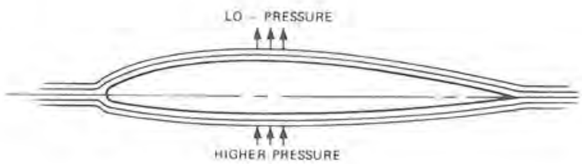


FIGURE IX

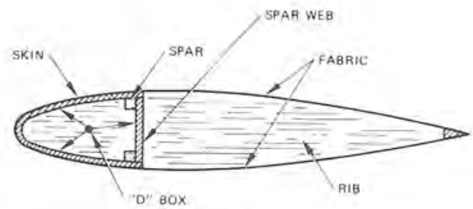


FIGURE X

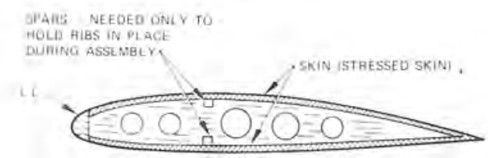


FIGURE XI

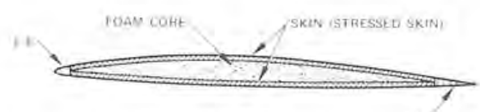
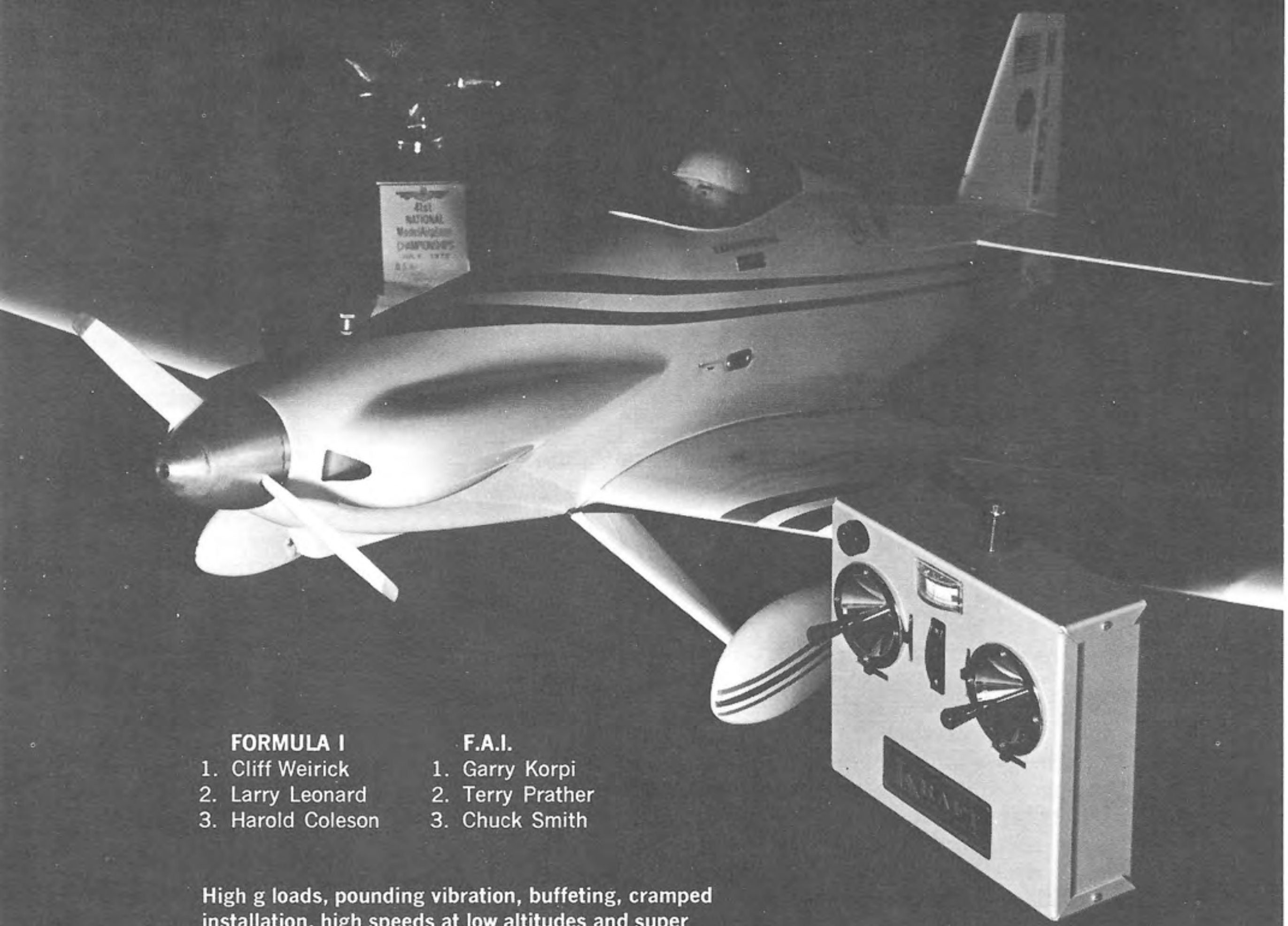


FIGURE XII

(CONTINUED ON PAGE 24)

Victory



FORMULA I
1. Cliff Weirick
2. Larry Leonard
3. Harold Coleson

F.A.I.
1. Garry Korpi
2. Terry Prather
3. Chuck Smith

High g loads, pounding vibration, buffeting, cramped installation, high speeds at low altitudes and super sensitive controls . . . no other part of the radio control sport demands so much from the radio control system as does racing. Perhaps that's why 70% of the entrants in the racing events of the 1972 Nationals used KRAFT equipment.

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World's Largest Manufacturer of Proportional R/C Equipment

WINGS: THEORY & PRACTICE

(Continued from Page 22)

WING CONSTRUCTION – There are countless ways of constructing wings. This article will discuss three of the generally standard methods.

a. *Build-up, D Box and Fabric* (Fig. X): This type of construction provides for a reasonably stiff light-weight wing with good torsional characteristics provided that the leading edge cap ties all the way from the top of the spar web to the bottom. If the leading edge cap does not tie to the top and the bottom, nearly all torsional qualities are lost and the spanwise bending becomes asymmetric. This construction is well-suited for large, constant chord and/or thickness wings.

b. *Built-up Sheeted* (Fig. XI): In this method of construction, the major wing loads are taken by the skins rather than by a spar box (stress-skinned wing). This is probably the most efficient of built-up wing structures. The spars need be only as required to hold the ribs in position while applying the skins. Because the wing loads are taken by distributed shear stresses throughout the skins, stiff spars should never be used as they represent stress risers and inflection points in the wing structure. Naturally, this type of construction lends itself to smooth super finishes but one should be careful not to sand too vigorously near the center section, that's the most heavily loaded part of the structure.

c. *Foam Core-Sheeted* (Fig. XII): This method of construction is one of the later entries to the wing technology. It is quite predominant in racing aircraft. This type of wing is, of course, a stressed-skin design with a foam core forcing the skins to maintain their shape. Many advantages are obvious; tapered wings, variable thicknesses from root to tip, washouts, cambers, etc., are quite easy to build in when cutting or molding foam cores. They are quite rugged and reasonably impact resistant. In addition, the foam cores tend to absorb the vibration and acoustics load from the engine. The greatest advantage is in the ability to gain a smooth and accurate shape transition from root to tip with only two templates (one at each end); the latter being considerably easier than having to plot all mid-point rib airfoils on a tapered, varying thickness built-up wing. A myriad of skin materials have been successfully used on foam wings including cardboard, fiberglass, plywood, veneer, balsa wood and various plastics. Balsa, however, is still the best bet for the average modeler. One thing is very important with these wings, the joining of left and right-hand panels. Auxiliary spars should always be avoided, they cause stress risers and inflection points just as in the built-up stressed-skin wings. The joint should be made by carrying the skin shear stresses from one wing panel to the other by using a fiberglass or celastic doubler all the way around the center joint. This will give a wing which will bend uniformly throughout its length when loaded.

CONSTRUCTION OF PYLON RACERS

by Dave Lane

Dave Lane on the Transmitter with Jack Stafford calling for him.

The first thing is to decide what type of Formula I ship to build. They are all about the same in complexity, so it really boils down to your particular taste in airplanes. Once you decide, and have purchased that box full of balsa, plastic and wire, read the instructions and study the plans until you understand what the designer is telling you. This is the most important step of all.

I usually start by building the fuselage, then the tail, and the wing last. Use a good grade of white glue, such as "Tite Bond" and a 15 minute epoxy such as Devcon or Hobby Poxy. Check the fuselage sides to be sure they are identical, add any doublers, etc. and glue the sides together at the tail. Slip the bulkheads in place and pull the front of the fuselage together with masking tape. Now that all the parts fit, glue the bulkheads in except for the fire wall. Check the alignment here to be sure the fuselage is straight. We will epoxy the fire wall in later. Complete the basic fuselage structure per instructions but only tack glue the lower nose block, set aside and start on the tail group. Tack glue the control surfaces in place on the stab and fin and carve and sand the complete unit to the desired air foil. Carefully cut apart and install the control horn and hinges.

Now, look at that wing: if it is all wood, I won't trouble you with any more nonsense, but if it is foam, read on. Do not throw away the foam that the wing cores came in. This block will be used as a jig when covering the wing cores with the wing skins. Check the wing skins to be sure there are no splits or cracks. Be sure the edges are straight. Pick the stiffest skins for the leading edge top and bottom. Trim the trailing edge sheets as required and mark so you know which skin goes where on the core. Use a good grade of contact cement that is compatible with the foam (Best Test Rubber Cement works well, or "Core-Grip"). Use a 1-1/2" or 2" foam brush (89¢ at Standard Brands paint store) to apply the glue to the wing core and balsa skins. Let the glue air dry for at least 20 to 30 minutes. Put the core in the core block and start covering the top of the core beginning with the leading edge skin. Be sure to clean the contact cement from the edges of the wing skins to allow a clean surface for either a white glue or epoxy glue seam.

After you have skinned the wing core, be sure to check each wing panel for warps and bows. If there are any, straighten the panel by twisting and bending in the opposite directions until the desired amount of washout is obtained. Glue the leading and trailing edges on, wing tips, etc., and set aside to dry.

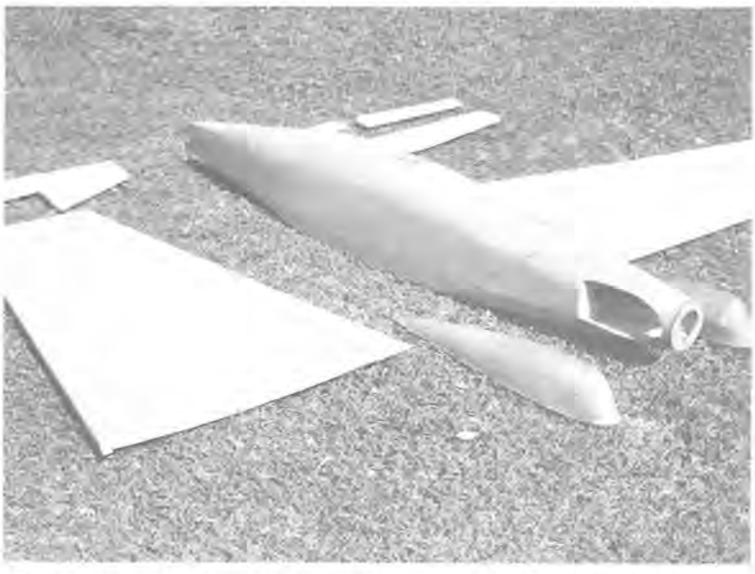
Now, back to the fuselage. Carve the fuselage to the desired shape and sand with 220 grit paper. Now, cut off the lower nose block, remove the fire wall and drill as required for engine mount, install blind nuts, etc. Take that old bashed up .40 that doesn't work anymore, cut off the cylinder and use the crank case and front end for a dummy engine to determine the exact fire wall location. Mount the engine mount to the fire wall, the dummy engine to the mount, slip the whole mess into the fuselage, mount a spinner to the front end with a 1/32" ply spacer between the spinner and the nose ring and epoxy the fire wall in place. Epoxy the nose block back on, cut out the side for the engine, remove the dummy engine and install the "good" engine and detail the fit as necessary.

Now, back to the wing. Carve and sand the panels to the desired air foil, epoxy the two panels together with the proper amount of dihedral and complete per instructions. The important thing here is to be sure the wing is straight and the aileron linkage is free but not sloppy. Be sure to tape the center section joint with either glass cloth or celastic (2" to 3" wide).

Now comes one of the critical points in building a Formula I. Tape the stab and wing to the fuselage. Prop the fuselage up on a flat surface and measure the relationship of the stab to the wing. The wing and stab should be zero zero degrees to the thrust line of the airplane and to each other.

Some minor adjustments will probably be needed to meet this requirement. Also, at this time, check to be sure the fuselage is perpendicular to the wing and stab. Allow 1/32" gap between the wing and fuselage for the 1/32" ply fillet bases. When you are satisfied that the wing and stab are correct, epoxy the stab and fin in place. Complete the fuselage at this time with the installation of the cockpit, cheek cowls, fillets, etc.

I hope this has helped on some of the details of building a Formula I. Keep them light and nose heavy with minimum control surface throws. LOTSA LUCK AND GOOD FLYING!



Minnow Formula I racer during construction, Note: Foam wing core, fiberglass check cowls and balsa fuselage with fiberglass covering.

INSTALLATION OF RADIO EQUIPMENT

by Cliff Weirick

Cliff Weirick

Probably the most important part of Pylon racing is the care with which you install your radio control equipment in the airplane itself. We all know, of course, that the radio control equipment is the heart of the system and, everything you do with that airplane depends upon the reliability of this radio equipment. It goes without saying that proper installation is a *must.*

The two main things we have to contend with in Pylon racing are the high vibration from the engine and the G forces resulting from turns. We have calculated at one time or another that some of the turns have G forces in excess of 30. In other words your 5 lb airplane now weighs 150 lbs. Imagine what this is doing to everything inside of it.

Let's talk about mounting the servos first, as they are the work horse of the system. Every bit of vibration, flutter, etc., that happens to your airplane is transfered back to them through the push rods. When at all possible use servo mounting trays. The manufacturers of radio equipment generally have trays available for their different styles of servos and I heartily recommend that you use them. They serve two functions. Number one – they give you a very neat installation, and two – they serve to further isolate the servos from the engine vibration.

Let's take a minute and talk about the push rods themselves. There should be absolutely no slop in these because the minute you have any, you are asking for flutter of some kind. I prefer to use fiber glass aero shafts with 1/16 inch piano wire on each end. These have worked extremely well throughout the years and I heartily recommend them.

Let's talk about the battery pack for a minute. Generally speaking, this is up in the nose of the airplane below the fuel tank. Believe me, you can not put enough foam around it; use all you possibly can. Generally, people tend to look at that battery pack as a way to balance out the model and worry very little about shock-mounting it. Rest assured, it is just as susceptible to vibration as any other piece of your radio equipment. As a matter of fact, I think you could probably call it one of the weakest links. One other thing, wrap that battery pack in a baggie or something of this nature before you install it. You would be surprised what 70 percent nitro does to the nylon case around these battery packs.

The switch harness should be mounted on the side of the fuselage opposite the exhaust. The oils that we use in the fuel tend to run back the side of the fuselage and will get in the contacts of the switch harness and some of them are detrimental to the operation of the switch itself.

Now, the absolute heart of the system, your receiver. I think its a known fact that the receiver is particularly susceptible to vibration due, at least in part, to the very fragile crystals that are used in the Super Heterodyne receivers. For this reason again, there is just no way you can get too much foam around the receiver. I pack mine rather loosely with 1/2 inch foam built up to probably in the neighborhood of 2" thick by the time I'm all through, and the receiver is just very gently held in place by this foam. I do not believe in wrapping the receiver with foam and then holding it in place with tape or rubber bands; this doesn't work. When you collapse the foam, you have destroyed its purpose. Bring the antenna out of the fuselage as close to the receiver as you possibly can and run it to the top of the fin. A lot of fellows like to run it back aft along the bottom of the fuselage. Why, I don't know; the amount of drag caused by the antenna wire is negligible and I want that antenna up where I can see that I've still got it. I have known one or two occasions where the antenna wire was torn off and guess what happened the next flight.

Now, the wires from the receiver to the servos. These should be neatly grouped together and perhaps even taped with masking tape to hold them in place. Don't make the inside of the thing look like a steel wool ball. Look for a neat installation, get those wires out of the way down out of sight where possible after you have plugged the servo in. Tape it so that it can't come unplugged.

Now that we have the equipment installed in the airplane, lets talk a little bit about maintenance. After the races are over, assuming that you still have an airplane, give everything a good checkout, push rods, servo installation, the mechanics of the thing, all these are very important. Check it when you have just finished with the races and have gone home, check it again before you are ready to go to the next one. You can't check it often enough. If you make an extremely hard landing or something of this nature, pull the wing, take a look. I myself have had rails break loose inside the fuselage just from a hard landing. Reliability is the watch word of Pylon racing. It's not always the fastest guy that wins, it's the guy that can go out there every heat and go 10 laps as fast as he knows how.

FINISHING WITH EPOXY

by Bror Faber

Bror Faber

You have just spent weeks building the fastest, prettiest, truest and lightest Formula racer of the decade. Engine has been in and out 272 times, tank and radio installation almost made you gray before your time, but you are now ready to paint the bird. Naturally a race is coming up quick, so you're going to have to rush it a bit. You know how long it takes to Silk and dope (and sand, and dope, and sand, and . . .). The ads for epoxy paint are outdoing each other in vying for your attention. Your mind is made up, epoxy is the way to go? now, which one: Yours truly has had some experience with the two top products now on the market: Hobbypoxy and K & B Superpoxy. I personally think they're both great, but there are definite differences between them which will be covered later. Let's first go through the most important step: preparation and priming.

Because of the light color of balsa wood, that fantastic structure you have prepared is far from blemish-free, even though you may think it is perfect. Second, because of the very high load factor in Pylon racing, we want to strengthen the structure as much as possible without adding *too* much weight. Consequently, after one more sanding (400 grit is plenty), we put a coat of polyester *coating* resin on all wood parts. Do not confuse with the other two very common resins: casting resin and bonding (boat) resin! There are several good ones on the market: Francis, K & B, Hobbypoxy and several others. I like to mix it with ample catalyst so it goes off in about 10 minutes. Use standard brushing technique with a fairly stiff brush. Don't forget to wash out the brush in acetone *before* the stuff goes off.

The coating resin sands relatively easy as opposed to the "epoxy glue" routine. Sure, the Hobbypoxy Formula II glue makes the wood *Very* strong, but be prepared for a week of scraping and sanding. Usually, I don't have time for a week of that. Use the wet or dry type of paper, I like about 220-240 grit. Though you may use it wet to knock off most of the high spots, change to dry as you get close to the wood. Don't worry if you should go through in spots. You should easily be able to finish sanding the whole bird in one evening. Just before you quit for the evening, brush on a second coat of resin. The following day sand this coat down. Remember, the resin weighs a bit, so you want to remove as much as possible, without breaking through this time.

Before we proceed with the next step, I'll mention a slightly different technique which appears to have a lot of merit.

Obtain some of the New K & B superlight 3/4 oz. glass cloth. Pre-cut pieces to roughly fit the various parts of the airplane. Apply resin as outlined above, but do only the area for which you have a piece of cloth. Next lay the cloth over the resin. Now take a roll of toilet paper and roll it over the cloth. This soaks up excess resin and also lays the cloth in intimate contact with the wood. Proceed to the next section in like manner after you peel enough toilet paper off the roll to expose the unsaturated part. It works great even on curved areas. After resin is cured, cut off excess cloth and sand. You'll find very little sanding being necessary, particularly if you were careful when you laid on the cloth. In most cases a second coat of resin is not necessary, and would only add weight.

Now back to Step II: primer. No matter which you use, it's heavy! If you are going the Hobbypoxy route, mix up half and half Hobbypoxy Thinner and Hobbypoxy Filler. Do *not* use "Stuff" for this purpose. I know, I know, it sands so easy, but it doesn't attach itself to the paint well enough. So spray on the soupy Filler-Thinner mixture. It'll dry hard in about 3-4 hours. *Wet* sand with 240 grit, and get as much as possible off. You want only the low spots filled, and a very thin coat, almost a haze on the whole structure. Pin holes not filled, or *very* small spots may be fixed with "Stuff." Be sure you wipe everything off with wet paper towels after you're through sanding.

Nine times out of ten I've been lucky with the color and use only *one* coat (plus trim color). Mix the Hobbypoxy color without adding hardener until you get the shade you want. To get "cream" as an example I take a large (8 oz) can of white, add one teaspoon yellow. Then in a separate container, I mix 4 parts red to 1 part green to come up with a warm chocolate brown. I then add this brown 1 teaspoon at a time to the white with yellow mix until it's right. If you measure all components carefully and write it down as you mix, you can come awfully close on a second batch should you need it.

Make sure you mix your color and catalyst according to instructions, and make doubly sure you let it sit at least one hour after you mix it! Just before you spray each part, wipe it with a tack-rag. I have found that filtering the paint through a discarded nylon stocking helps tremendously. Make sure your spray gun is scrupulously clean. Then pour the mixed paint from your mixing container through the nylon stocking into the gun. I have never found it necessary to thin the paint, although some modelers claim it eliminates any orange peel. I believe the most dust free area in the whole house is the shower. Do not turn on the forced air heat, instead put a small electric radiant heater (no blower) in there, then hang the parts on the shower curtain rod to dry. If you paint late at night, an extra application of Arrid, Ban or similar may prove helpful the next day.

For masking, I have had best results using regular Scotch tape. It curves reasonably well, and you get a very clean edge. To protect large areas I use Saran-Wrap or similar clingy plastic wrap. No dust or fuzz that way. Mix the trim paint normally and spray. Although a little tacky, neater edges are obtained if you strip the masking off while the paint is still wet.

If you go the K & B Superpoxy route, the technique is very similar. Mix primer and primer-catalyst (make sure you have the right catalyst) half and half, and spray. This material sands very easily; for best results use 3M Tri-Cut paper. Again sand off as much as possible. When I first tried this route, I jotted down some notes on the Weight gained on a Mustang wing through the Various stages of finish. The bare wing weighed 9.5 oz. After applying the resin and cloth and including the 6 oz. cloth at the dihedral joint, it weighed 11.7 oz. After priming, sanding and ready for color coat, the weight was 13.2 oz. Not bad when you know you have finished a little over 900 square inches! By the way, the completed airplane with wheel pants and ready to fly was exactly 5 lbs.

The Superpoxy paint differs from Hobbypoxy in that is requires no ingestion time at all, just mix and spray. I like to add about 10% thinner, even though the paint is already a good bit thinner than Hobbypoxy. The shine of the finished Superpoxy is hard to beat, and after it's fully cured, impervious to most anything.

For those of you who like fiberglass fuselages, be sure you wipe them extremely well with acetone to get rid of all traces of mold-release and wax. Sand well, wipe again, and then go right into the primer stage.

A guide summary of the difference between Hobbypoxy and Superpoxy:

HOBBYPOXY – ***Primer:*** Filler & Thinner. A little hard to sand, use wet paper.

Paint: After mixing with catalyst, it must stand and digest for at least 1 hr. Cures a bit slow. Very good selection of colors. Both Satin and Gloss catalysts available.

SUPERPOXY – ***Primer:*** Superpoxy. Sands very easy, use dry paper.

Paint: Can be sprayed immediately after mixing. Not too many colors available; using their color chart and mixing, almost any color can be obtained. Dries quickly. Very hard, yet flexible.

Both epoxies can be sprayed at night. As a matter of fact, I've even sprayed while it was raining outside with no blushing or other detrimental effects.

FINISHING WITH BUTYRATE DOPE

by Ray Downs

Ray Downs

In any finish procedure, keep in mind that the ultimate finish is no better than the preparation underneath, which means the use of lots of sandpaper and plenty of elbow grease.

After construction, all pronounced imperfections such as cracks and dents should be filled; I use the tube type Spackle. In the first use of sandpaper, use varying grits starting with 220 and finishing with 400 until the model is very smooth. Two coats of thinned clear dope – sanding in between with 400 wet or dry paper – are followed by covering with light weight or 00 silkspan, bonded with a coat of medium thin clear dope. All seams should be feather sanded.

To assure a smooth-as-glass final finish, an epoxy or resin coat is applied. I use a commercial epoxy thinned 50% with butyrate or acetone thinner to the consistency of water. Brush one coat and let dry overnight – then more sandpaper, 320, and a second coat dried overnight and more sandpaper, 400. This is the foundation upon which the ultimate finish is based and at this stage, there should be no imperfections, since they will show up in the end product.

Before applying the color, a coat of sanding sealer should be used for better adherence of the color coat. The color coat should be sprayed. After a first coat is dry to the touch, a second coat is applied which should dry for 24 hours.

Next comes the hard part – the application of the aforementioned "elbow grease." Rub out the model with a medium rubbing compound until smooth and glossy, then clean with Energene or lighter fluid to remove all oils and waxes.

Because of the smoothness of the surface, the trim can be brushed on without showing any brush marks and flowing perfectly. However, when masking off the trim make sure the masking tape is rubbed down tight, and it should be sealed with a coat of clear dope around the edges to prevent the trim coat from running underneath. After removal of the trim tape, lightly rub the edges to remove any ridges left by the tape and trim coat.

For a final touch, wax the model. I use Johnson Pledge in a spray can. To protect the finish and keep the fuel from attacking the finish, it is a good idea after each flying session to rewax your model.

It is a lot of work but the end result is well worth the effort.

FINISHING WITH ACRYLIC LACQUER

by Terry Prather

Terry Prather

Acrylic lacquer has many advantages and disadvantages just like any other type of finish. Not being hot fuel proof is its main disadvantage, although burned fuel and oil do not appear to hurt it. The advantages I have found are as follows: (1) Ease of application (2) Fast drying qualities (3) Easy patching qualities (4) A mediocre paint job can be rubbed out with minimal effort to be just short of excellent.

Using acrylic lacquer I was able to get the number one spot in Formula I scale judging at the 1972 Nationals. I also won the most outstanding aircraft award at the 1972 Tangerine meet. (I should mention I did share this award with Bob Smith who used a Super Poxy Finish.)

Preparation of the Surface: As with any finish the preparation of the surface before painting is the most important and takes most of one's time. I spend about 75% of my finishing time in preparing the surface.

You should start with a smooth balsa surface free of dings and dents. I use 3/4 oz. to 1 oz. fiberglass cloth in a manner similar to traditional silkspan or silk except instead of dope I use resin. When applying the cloth the resin should be thinned about 25% to avoid getting a large amount of resin trapped under the cloth. A standard resin thinner can be used, called Styrene-Monomer, or Acetone may be used. After the initial coat of resin, two more coats of resin should be sufficient to get a mirror-like surface; naturally a lot of elbow grease and sandpaper are needed between each coat. I usually start with 120 to 150 grit sandpaper and finish with 220 grit.

Applying the Acrylic Lacquer: I have seen good results with many different brands of acrylic lacquer. I therefore can't recommend one above the other.

A primer coat should be used to fill in any small dents not already filled with the resin. I use a white primer coat. The primer coat should bring all surfaces to a very even color. I usually apply 2 or 3 primer coats and use 400 to 600 wet sandpaper between the coats.

One of the most important things about applying the color coat is getting the paint to the proper consistency. I have found that 2 parts thinner to 1 part paint is usually a good starting point. If the paint doesn't flow, more thinner should be added. I usually apply 3 coats of the basic color at 35 psi. I wet sand after each coat only in those areas which are rough or where the paint did not flow properly. Be sure to use worn 600 wet paper or you may scratch the surface.

The trim colors can usually be added within 3 to 4 hours after the last basic color coat. (Dry warm weather) Masking the secondary colors should be done with a vinyl tape or 3 M's striping tape. This will prevent the edges from bleeding.

After all color coats are added, any bad spots in the surface should be smoothed out with 600 wet sandpaper. I then apply 3 to 4 coats of clear acrylic lacquer.

Your finish should now look better than 90% of the other planes on the field. If you want that little extra, use a polishing compound on the finish, then use a cleaner wax. A bit of spray wax should bring your finish to a dazzling shine.

PRESSURIZED FUEL SYSTEMS

by George Aldrich

An engine with a pressurized fuel system is no longer an oddity. It is used in almost every type of modeling that requires an engine. I will cover the various methods and the technical problems involved with each kind of pressurizing system.

Let it be understood at the outset that pressure alone will not add power. Only when the venturi or carburetor bore is made larger, thereby increasing the engine's ability to breathe a larger air-fuel mixture does a pressure system give more power.

Air Blast – Oddly enough, this is a type of pressure feed, although it has been used for years. All that it requires is the vent tube or tubes to be turned or slanted into the air blast. Nothing more than a piece of fuel tubing cut at a 60 degree angle and pushed over the vent tubing in the tank will do. This puts a positive head of pressure, be it ever so slight, on the tank.

Timed Crankcase – This system gives more pressure than any other type except the bladder or pacifier method. By timed pressure, we mean the pressure is timed by the rotary valve. Whether it is front or rear rotor makes no difference. The pressure goes into the tank on the positive impulse from the crankcase and, when the rotary valve closes, it closes the system, except for the feed line going to the engine This amounts to a "stored pressure" with a multitude of little impulses going into the tank.

Obviously, if the tank level were to remain constant, or when the tank is full, the pressure will build with each additional pulse. But, as the tank empties, it is compensated or dampened as the air in the tank is more compressible than the fuel.

Regardless, this is a rather high pressure system and with high pressure comes needle valve setting problems. In other words, with timed crankcase pressure, the engine becomes more critical to set. There can be some confusion as to which type of pressure is employed on some engines because the fittings have similar locations.

To clarify this problem: If the engine has a shaft valve (venturi in front), timed pressure must be taken from a fitting that is located on the front housing; if the engine has a rear rotary valve, the timed pressure is taken from a special fitting threaded into the backplate. Close inspection, with this pressure fitting removed, will reveal a tiny hole going through the backplate at the bottom of the threaded hole. NOW, here is where confusion arises – untimed pressure is also taken from the backplate on both front and rear rotor engines; the difference is that the pressure fitting is either located in the upper left hand backplate screw hole or in a special location in the backplate on some front rotor engines. The important point is that in order to have timed pressure, the pressure hole must be in such a location that the rotary valve can close the "system."

Untimed Pressure – It has already been made clear that untimed pressure is taken most anywhere from the crankcase as long as it is not timed by the rotary valve. Even with this type of pressure, the needle valve setting can be very critical. Unlike the timed pressure system, there is a way to decrease or eliminate this problem. The idea is to restrict the amount of pressure that gets into the tank. This can be done by soldering a piece of wire into either the pressure fitting or the pressure tube in the tank. As soon as the solder cools, the wire is extracted with a pair of pliers. To make this operation easier, either use a piece of stainless steel wire (available at fishing tackle stores as leader material) or "smoke" a piece of music wire with a match to keep the solder from "tinning." Be sure this is done only on an untimed system, as to do so on a timed system will reduce the pressure too much, causing the engine to starve or run over-lean. The size of the wire is most important. For .35 and up, an .014 to .016 diameter wire is ample.

The untimed system is my favorite, as it offers more consistency than a timed system. Precautions to avoid clogging of the pressure line such as regular cleaning, filters, etc., are most advisable with any pressure system.

With either the timed or untimed system, the pressure in the tank can back up through the pressure line, filling the crankcase and flooding the engine. This problem can be avoided by disconnecting the pressure line while filling the tank or keeping the nose of the model up before starting. Some metal tanks have a ball check valve in the pressure connection to solve this problem.

Bladder or Pacifier – This system can produce the most consistent engine settings if utilized properly. It is absolutely essential that the needle valve be capable of closing completely with this type of pressure. There are only two needle valve assemblies that give really excellent results on this high pressure system presently available. Both are of the racing type with a collet lock nut and are made by K&B Mfg. and Filli Rossi. They have a very fine thread, perfect needle valve seat, and give a broad, consistent, uncritical setting. Some engines will require special work in order to use them, but they are well worth it.

This collet type needle valve is most often used improperly. Many do not like them, as the collet nut will loosen or the needle valve will get loose from wear. The reason this happens is that they are used in the same way as a ratchet type: the collet is tightened only enough to keep the needle valve from turning from engine vibration. To eliminate this problem, simply tighten the collet nut so that the needle valve cannot be turned at all, after the correct setting is obtained.

This highest of pressure systems can give the most consistent, fastest performance but it is the most critical.

Muffler or Exhaust – Unlike the higher pressure systems, the venturi or carburetor bore cannot be opened an unlimited amount with this type of pressure. By installing a pressure fitting in the muffler (preferred method) or in the innermost corner of the exhaust stack, a positive pressure to the tank can be realized. This system is most applicable to stunt or pattern type models. Pressure from the muffler can also be used in conjunction with the new, big bore pressure carburetors. As with any pressure tank system, there are two major connections – one to the engine and one to the pressure connection. Filler tubes may be employed, but they must be capped if this or any pressure system is to work.

Fuel Pump – To date I have only seen prototypes of a unit soon to be marketed. When proven units are available, they promise the most consistent of engine settings ever. With a fuel pump, tank location, fuel level, etc., will cease to be of any importance. The tank can be mounted on the tail and the engine will still get ample flow from the fuel pump. These can operate on untimed or muffler pressure.

RACING ENGINES

by Clarence Lee

Clarence Lee

The .40 cubic inch displacement engines used in pylon racers develop more horsepower both per cubic inch and per pound than any full-sized reciprocating internal combustion engine in the world. Nearly two horsepower is being developed in an engine weighing only 10 or 12 ounces. This figures out at about three horsepower per pound of weight. Full-sized automotive and aircraft engines that can develop over one horsepower per pound are considered exceptional, and very few can achieve this power-to-weight ratio. Those that can are the engines in drag racers, Indianapolis type racecars, etc. Even though we are already using the most powerful engines for their weight in the world, I receive many letters every month from fellows wanting to know how they can get just a little more out of their engine. How do they go about "hopping" the engine up – what modifications can be made to the ports and timing to give more power, etc. In years past modifications could be made to the engines by enlarging the ports, changing the timing, raising the compression ratio, boring out the carburetor, etc.; these changes would result in a considerable increase in performance. However, in an effort to stay competitive, the engine manufacturers have incorporated all of these refinements into the engines as you receive them now. The old days of hopping up an engine in the sense that we knew it are gone. The engine comes to you hopped up to begin with. There is nothing in the way of radical rework that you can do. Most rework now is limited to cleaning and freeing up the engine and experimentation with compression ratio and squish band clearance, which I will discuss later. Getting the most out of an engine now depends on how it is set up and fit. If you were to go to your local hobbyshop and purchase six engines of the same make, break them in exactly the same way, etc., the chances are very good that one would be superior to the other five. Three or four of the remaining engines would run very well, but not as well as the number one engine, and the final engine might be a real bummer. Naturally you wonder what can cause this variance between engines of the same make. These are production engines and must be built to specific tolerances. Although these tolerances are very close, it is possible, through a ganging of tolerances, for a variation between engines to occur. Port timing in one engine will be a little different than in another, bearing fits a little tighter or looser, ring or piston seal better, etc. For a manufacturer to spend hours trying to make every engine identical would make the cost of the engine prohibitive. So in this article let's look into a few of the things that determine whether an engine is going to be just another engine or a real screamer, and try to eliminate the bummer that somebody is bound to get.

One of the most important secrets, if it may be called that, in getting an engine to really go is the elimination of all drag. The engine must be absolutely free. The slightest drag from a rotor that is fit a little too close, or a bearing that is a little on the tight side, can cause a drop in power of as much as a thousand rpm. Tight bearings and a tight rotor could well be the reason for that "bummer" that occasionally comes along.

The first thing you want to check on any racing engine is the crankshaft bearing fits. Start by flushing the bearings thoroughly in acetone or lacquer thinner to remove the thick oil. Now check the bearings for a slight bit of fore and aft play. It is very essential that the bearings do have a slight amount of end play. When the engine gets hot the aluminum housing will grow more in length than the steel crankshaft. If there is no end play to allow for this growth differential, the bearings are going to bind. If you should have an engine with no end play, it would be best to return it to the manufacturer or to someone who specializes in Custom work rather than attempting to do the work yourself. It is common practice among old u-control speed men to loosen up the bearing fits by using emory paper on the crankshaft and bearing housing bores, but I do not recommend this unless you have had a lot of experience and know what you are doing. Most of the fellows flying R/C pylon do not have this experience and could well end up making things worse.

You will also want to check for freedom of the crankshaft by making sure the counter-balance rocks to dead bottom with no drag. Your later racing engines now have what are called banded cranks. The crankshaft has been cut away internally for counter-balancing action and an aluminum or brass sleeve pressed over the outer diameter. This makes a solid disc crankshaft that appears to not have any counter-balance. Don't let this fool you, as the crankshaft is counter-balanced. This banding is done in order to pack the crankcase resulting in better pumping action. If the counter-balance side of the crankshaft does not fall to dead bottom by its own weight, there is a bind somewhere that must be eliminated.

The fit of the rear rotor is very important for proper engine performance and yet few pylon race fliers ever check it for correct fit. A few thousandths too tight or too loose can make a considerable difference in the way the engine turns up. First of all make sure the rotor spins dead free. Check for any rough edges or burrs that might be hanging up and causing drag. Push the rotor itself against the back plate as you rotate the rotor and see if there are any catches or bumpy feeling, particularly as the opening in the rotor passes over the opening in the back plate. The rotor must revolve absolutely smoothly. Steel rotors as used in the Supertigre and H.P. should be set with .003" to .004" clearance. The plastic rotor in the K & B expands and should be set slightly looser at .004" to .005". Always check the seal of the rotor. You can do this by assembling the engine, and then with the glow plug removed revolve the crankshaft in the direction the engine runs while holding one finger over the pressure fitting and another over the backplate intake opening (carburetor removed). As you rotate the engine you should feel a positive build up of pressure which is suddenly released when the bypass port opens. This is your crankcase base pressure. Now do the same thing still keeping one finger over the pressure fitting but with the air intake open. Base pressure should remain the same. If it is less now, the rotor is not sealing, and the cause should be determined. Any high spots on either the back plate or rotor should be faced off using #360 grit Wet or Dry emory paper. Place the emory paper on a dead flat surface and use an oscillating motion. Be sure and use a light oil such as 3-in-1. Reassemble the rotor, setting the clearance properly, and check the seal again.

With the crankshaft and rotor free, the next step is the piston and sleeve. Not too much is involved here other than to be sure the engine has a good compression seal. If the engine lacks compression, it is not going to turn up and should be returned to the manufacturer for service. When checking the K & B for compression, be sure and flip the engine smartly with the propellor. The K & B uses a "no tension" ring and in some cases will have little compression when turned over slowly. The engine must be flipped so that compression pressure will expand the ring. After the engine has been run the ring takes a set. Some rings will expand slightly and others contract. This is perfectly normal. When the engine is running, combustion pressure expands the ring and makes the compression seal. The principle of operation is different than the H.P., which uses a conventional expansion type of ring. The Supertigre does not use a ring and instead uses a lapped aluminum piston in a chrome plated brass sleeve, which is where the ABC designation comes from.

Check the piston and sleeve for any burrs, sharp edges, etc., and clean these up if necessary. Check the fit of the wrist pin in both the piston and upper end of the rod. This should be a nice slip fit. If by chance the fit should be tight you can loosen the fit up with a piece of crocus cloth wrapped around the shank of the appropriate size drill. In the case of the K & B and H.P., push the piston through the sleeve and make sure ring drag is even from top to bottom. If any catching is noted at the ports, determine why. The lapped piston in the Supertigre is intentionally tighter at the top of the sleeve. This is to allow for expansion of the sleeve when the engine is running. Do not loosen the piston up so that it will fall through the sleeve by its own weight. This is done with lapped cast iron pistons but should not be done with the aluminum.

The final item we want to check is the head. The K & B, H.P., and Supertigre all use "squish band" heads. As the piston approaches the top of its stroke, the fuel mixture is squished to the center of the combustion chamber by the band around the outer edge of the head. This squish action creates turbulence that results in better combustion. For this squish action to take place the distance between the top of the piston and bottom of the squish band must be set accurately, as it is a very critical dimension. This squish band clearance is critical to air density, humidity, temperature, and naturally fuel. The difference of a few thousandths of an inch can in turn make a difference in the engine of as much as 500 rpm. In dry light air a closer clearance can be used than in moist heavy air. This means fellows in Florida have to run more squish band clearance than those flying in Arizona. Generally however, .010" to .012"

(CONTINUED ON PAGE 38)


perfection

(Continued from page 36)

is a good place to start. Some fellows are running as close as .006" and as much as .016." Engines that do not have baffles on the piston can usually run closer clearances than those that do have a baffle. In order to change the squish band clearance, the head is usually set for a .006" to .008" clearance. Then shims are made from .002" brass or copper shim stock. Adding or removing shims adjusts the clearance. Actually this is more bother than most pylon pilots want to contend with, so setting the clearance at .010" to .012" will be a good compromise. However, many of the top racing pilots do change the squish band clearance for the weather conditions, often changing during the course of the day. So when you wonder how some of the fellows are turning in the low times that they are, it is paying attention to details such as this that is doing it.

This pretty well covers refinements to the engine. How the engine now puts out will depend on how you break it in and maintain it afterwards. This in itself is one of the secrets of a real screaming engine. We have all noticed that some fellows always seem to have good running engines and other always have problems. It is who is running the engine that makes the big difference. You can not run the engine too lean time after time, run it under dirty conditions, cart wheel on every landing, and still expect the engine to always develop its maximum power. And yet there are those that do, and when they get beaten at a contest are sure the other guy was running a special factory engine, had a secret fuel additive, etc. Most all of your racing engines are fit loose enough so that they can be raced out of the box, but this does not necessarily mean that they are broken in or anywhere near up to full power. Parts have to mate and polish together. This takes considerable running. Some of the strongest engines I have ever had were those with many hours of running. The older they get, the stronger they get, providing you do not run them too lean, stick them into the ground, run dirt through them, etc. And this is where most fellows fall down. Through lean running and general abuse the engine is actually burned up before it ever reaches full power.

Now the engine is only one part of a combination that determines how fast your airplane is going to go. In order to get maximum performance from the engine, the correct fuel, glow plug, and propeller must be used. The engine must be mounted properly and cooled properly.

Mounting and cooling the engine should be no big problem, but it is surprising the number of fellows who pay no or little attention to these important details. First of all the engine should be mounted to a precision machined aluminum mount. Any twist in the motor mounts results in twisting the mounting lugs of the engine. This in turn can cause a binding in the engine. An aluminum mount makes for a more rigid mount which lessens vibration and helps dissipate heat from the engine. You do not want to use wooden beam mounts in a pylon racer. When mounting the engine be sure that you do not have any offset thrust. A slight bit of up, down, or side thrust can result in a considerable speed loss. If you have to carry a little up or down elevator, right rudder, etc., to compensate for a misaligned engine, it only results in extra drag. Any time you deflect a control surface, you are increasing the drag of the airplane.

Cooling the engine is a simple matter of having an air entrance and air exit. Most fellows realize the importance of the air entrance, but it is the exit many seem to ignore. Be sure you use an exit that is half again as large in area as the entrance. Unless the hot air can get out it will build up a positive pressure inside the cowl. Cooling air rather than coming in the entrance will just flow around the cowl. A baffle to direct the air out the exit should also be used as well as a partition to separate the carburetor intake area from the flow of hot cooling air. You do not want this hot air to get to the carburetor area.

A means of supplying cool air to the carburetor must also be used. At the rpm these engines are running, a great amount of air is required. The engine will not perform properly if it has to draw its air through the cracks in the cowl, etc. Common practice is to cut an opening in the cheek cowl opposite the engine and then duct air from here to the engine. This works fine. You do not want to duct the air directly into the carburetor venturi (ram feed). This can cause problems with getting a constant needle valve setting in the air. Just duct the air to the carburetor area. Some of the fellows feel that the extra opening in the cheek cowl for an air intake also produces extra drag. Instead they have an opening in the side of the airplane to supply air to the carburetor area. Frankly I like the cheek cowl method myself. It is also a good idea to install a piece of air filter type foam in the cheek cowl. This will eliminate all of the dust, dirt, rocks, etc., that go through the engine and will not cut down on the performance of the engine in any way. It will in turn add greatly to the life expectancy of the engine. Many engines go over the hill long before they are ever up to full power due to dust inhalation through the carburetor air intake. Run a piece of filter foam in your cheek cowl for a few races and you will be surprised at the amount of foreign matter it picks up. I have found one of the best materials to be the plastic foam that Matty Sullivan uses in his anti-foaming fuel tanks. You can buy this foam for installation in your fuel tank but it can be used as an air filter material as well. Put a little light machine oil on the foam before installing in the cheek cowl.

The correct glow plug will depend to some extent on your particular make of engine, amount of nitromethane in your fuel, rpm at which you are propping your engine, etc. The glow plug that may work best in one fellow's engine may not necessarily be the best for yours. You will have to conduct a little experimentation if you want to find which plug will give you maximum performance. However, to start with, either the short heavy duty Fox plug or the short K & B (KB-1S) will work well. The K & B is usually a few hundred rpm faster but the Fox holds up longer with the higher nitro content fuels. In your particular installation maybe the long K & B will work better, or one of the Fireball line. The Fireball plugs do have a tendency to blow the seals and fellows using them have been curing this by placing high temperature epoxy on the stem of the plug. Always change your glow plug if the element becomes distorted or when it gets a frosted look. The frosted look means it has become crystalized and will break readily. Many fellows after determining which glow plug works the best for them will test run six or a dozen plugs, noting the rpm of each. Glow plugs of the same make, just like engines, will vary. Out of a dozen plugs one or two may run 300 to 500 higher than the others. These plugs are then set aside for one of those rough races that come along where you need a little extra.

Fuels are pretty well cut and dried. You may hear rumors about all kinds of secret ingredients being used, but don't fall for it. Every fellow that mixes his own fuel would like others to think that he knows of some secret additive that is making his brew a little more powerful than the other guys. This is just a psychological bluff. Different lubricating oils may be tried but the rest of the ingredients are the same. 50% to 65% nitromethane, (some have gone as high as 75%), 20% oil, and the balance alcohol. Some fellows will add a little propylene oxide, which is an igniter, to their fuel. As you use more nitromethane and less alcohol, the nitro does not want to ignite as readily, so propylene oxide is used. For oil most of the fellows are using either Klotz, or one of the Ucons, sometimes in conjunction with castor oil. The advantage of the synthetics is that they will mix easily with high percentages of nitromethane. Castor oil does not want to mix with nitro concentrations much over 50%. The addition of a small percentage of nitro benzene will allow nitro methane and castor oil to mix. However, nitro benzene is a very dangerous chemical to use and in my opinion should be banned from model fuels. This is the stuff that smells like shoe polish. It is absorbed by the skin and accumulative in your system. If enough is absorbed by your system it can result in major medical problems such as kidney failure. Frankly, it is much easier to use a commercially made fuel such as Supersonic racing fuel. You do not have to go to any exotic mixes to be competitive. Bobby Smith set the Formula I pylon record of 1:30 at Bakersfield in 1971 using straight out-of-the-can K & B racing fuel. In 1972 again at Bakersfield he lowered the record to 1:27.9 using K & B racing fuel that had been raised to 60% nitro. No secret formulations or ingredients. Since then the record has dropped to 1:22.1 and could easily go lower.

Finally we come to the propeller. Herein lies the biggest secret in getting an engine to go. If the engine is not propped right, it will not unload in the air and develop its full potential. Even a mediocre engine with the right prop will go faster than an extremely hot engine that is propped wrong. The propeller manufacturers try to give you the best product they can, but propellers just like engines have to be produced with production techniques. The additional refining has to be done by your hand. Propeller technology is a science in itself. There are many different theories as to how the propeller should be reworked. I am sure there are those that will feel that whatever I say is all wrong. All I can do is tell you how I do it, which is the same method used by Bobby Smith, Larry Leonard, and others that are turning in the faster times.

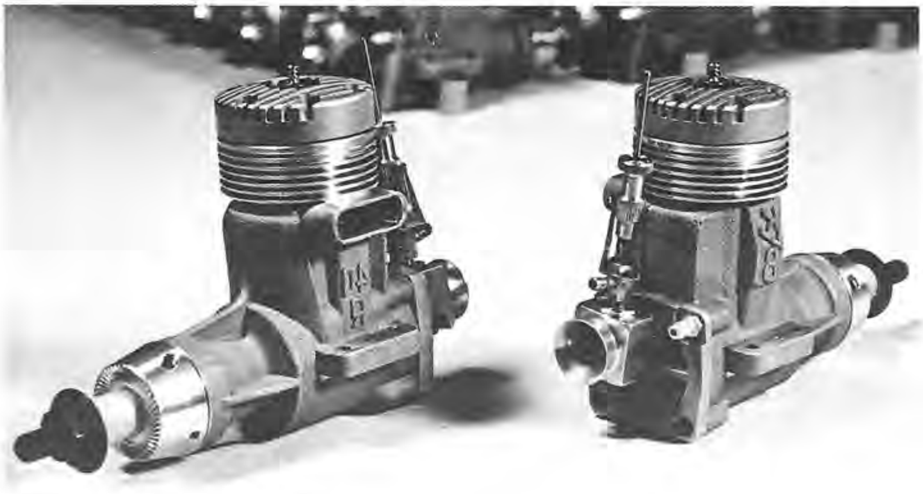
The propeller that works great on one fellow's airplane may not work as well on yours. Power of the engine, drag of the airplane, weight of the airplane, etc., all play a part. A clean five pound airplane can get away with less blade area than a dirty six pound airplane. Some engines will swing a little more blade area than others. So a little experimentation to determine the diameter and blade area for your particular airplane is going to be necessary. The first thing to do, however, is build a clean slightly-over-five-pound airplane.

I like to start with either the 9-8 or 9-8-1/2 Top Flite pylon prop. The first thing you want to do is check the hub for squareness. Both from side to side and in an up and down direction. If the hub has a wedge shape from side to side the propeller is going to be rotated very slightly. As an extreme example, an 8 pitch propeller could have one blade running at 9 pitch and the other at 7. The 9 pitch blade would hold the rpm of the engine down. If the propeller is tilted from top to bottom the tips will run out causing vibration even though the propeller has been balanced statically. The easiest way to check the squareness of the hub is with a pair of vernier calipers. You can pick up a pair of Japanese imports for under $10.00 that are very accurate. You want a pair that reads in thousandths. Always remember that the front face of the hub is the true surface from which the propellor is made. So when truing the hub remove material from the back side.

Next cut the diameter of the propeller to between 8-5/8" and 8-3/4". Diameter will be determined to some extent by the power of your engine. Start with 8-3/4" but if the engine won't turn up as you want, reduce the diameter. You want to prop any of your engines for 17,000 or over on the ground. If they go over 18,000 it is a good idea to increase the diameter of the propeller. You want to narrow the tips of the propeller slightly. If you have one of the 71 series K & B .40's, 5/16" is about right. For the new Schnuerle port K & B .40 and the H.P. and SuperTigre, 3/8" is good. Narrow the tips by trimming off the leading edge in a gradual taper starting about one inch from the tip. There is a reason for trimming the leading edge rather than the trailing edge. By trimming the leading edge you are moving the center line of the tip behind the center line of the hub. When the blade flexes under load the pitch at the tips will decrease slightly. This allows the ship to accelerate faster off of the ground and out of the turns. When up to speed the tips resume normal pitch. Trimming off the leading edge has left a blunt edge, so reshape the blade being sure to maintain an airfoil shape with the high point 1/3rd back from the leading edge. Your propeller is nothing but a skinny wing and must have an airfoil shape. Some fellows do not seem to realize this and as a result the thickest part of the blade will be towards the trailing edge. Needless to say a prop carved this way would be a loser. You want the leading edge to be sharp but with a small radius. The trailing edge should be knife sharp. Thin the blades down, especially at the tips. The leverage is at the tips and a thick blade here can hold rpm down. However, do not go so thin that the propeller cavitates. This is not particularly desirable. Actually this is nothing but tip flutter being caused by the propeller blades flexing too much. Choosing a very stiff propeller to start with will help considerably. Make all alterations to the propeller blades to the face of the blade. Do not touch the back of the blade other than to smooth it up with sandpaper. The back of the blade determines the pitch of the propeller. If you have an accurate pitch checker and want to true the pitch this is okay. However most fellows do not have a pitch checker and should leave this part of the blade alone. Do not wash out the tips. This was a recommended practice in years past; however, for the past year or so the propellers have the wash-out already carved in. If you carve in additional wash out you will be lowering the pitch at the tips too much. The tips will then be trying to hold the airplane back as the higher pitch center section is trying to pull it ahead. The prop would be fighting itself. Be sure and balance the propeller with an accurate balancer.

Some of the fellows like to use a little more blade area. In this case start with the 9-1/2" diameter series propellers leaving the tips and blade appropriately wider. The same style of propeller will work very well on the FAI ships, but start with the 9-7 Top Flite speed prop.

That about covers the engine and those things related to its performance. Due to the amount of material covered in this article I could not go into the detail that I might have liked to or there wouldn't have been space for other articles in the book. I have tried to cover the major points and hope that this article will be of some help in solving the mysteries of getting one of these pylon racers to go.



First run of the K&B Schnuerle-ported .40 engine.

IT'S WHAT'S UP FRONT THAT COUNTS!

by C. Telford

C. Telford

While the title phrase comes from an old Madison Avenue cigarette commercial, it can be applied more aptly to the engine/propeller combination of our pylon racers. Given two equally good pilots with reliable airplanes, the one who derives the most power from the engine up front is most likely to win. The purpose of this article, therefore, is to help the racing enthusiast to select the best engine and propeller for his airplane. We will treat these two items separately, but it should be pointed out that the engine and propeller must be tailored to each other in order to gain the most efficiency from each.

The Engine – To avoid going into great detail about engine terminology, we must assume that the reader has some knowledge in this area.

In selecting an engine for racing, there are several design features which have evolved over the years that one should expect to see. They are:

1. Two ball bearings on the crankshaft.
2. Rotary valve induction with large port area.
3. Forged or machined connecting rod with bronze bushings or caged needle bearings at both ends.
4. Flat topped piston.
5. Hemispherical combustion chamber.

Most of these features are necessary in an engine designed to turn about 21,000 RPM. Hardened steel or chromed cylinder liners and crankpins are desirable features which will not necessarily make the engine run faster but will make it more durable. The modern trend is to the "ABC" set up, an *a*luminum piston running in a *b*rass sleeve which has been *c*hrome plated. The piston is made from a special aluminum alloy which has a coefficient of expansion almost exactly the same as the brass sleeve. Under the heat of combustion, the sleeve and piston expand at the same rate, thereby reducing friction, while maintaining a good compression seal.

A newcomer to racing has only to look around and see what engines the winning fliers are using in order to decide what engine to buy for his own use. As of this writing he will find the HP40RV, K & B 40s, and SuperTigre G-40ABC most frequently in the winner's circle. He will also find that the winning engines have usually been modified by the fliers themselves or have been selectively hand fit by George Aldrich, Clarence Lee or the author. So the best engines are available even to the novice flier, but he may be better advised to wait until his flying skill has improved before he invests his money in the ultimate horsepower for his airplane. Once he is confident he can handle the airplane he may find that a finely-tuned engine will knock 10-15 seconds off his time.

Engine Performance – An engine properly set up and broken in according to the manufacturer's instructions should give hours of trouble-free operation. Naturally there are limitations which should be observed to increase the useful life of the engine. Care should be used in selecting the glow plug, fuel and propeller for the engine. The propeller will be covered later, so let us concentrate for a moment on the fuel and plug.

Fuel – Engines set up for the Formula I event will survive longer if the nitromethane content of the fuel is held to 50-60%. Since the ambient air temperature is a critical factor in engine cooling, the nitro content should be varied to suit local conditions. In hotter weather, less nitro should be used.

The oil content of the fuel is important in obtaining maximum performance and long life. For breaking in the engine and for initial test flights the fuel should contain about 25% oil. After the engine has been flown for about ten flights this can be decreased to a safe minimum of 20%. Thus, a fuel formula for average contest work will look like this:

55% nitromethane
20% oil (castor or synthetic)
25% methanol

In FAI Racing the fuel is supplied by the contest management and will contain 80% methanol and 20% caster oil. Nitromethane is not permitted. For this event, the engine compression ratio should be set up somewhat higher.

Glow Plug – The glow plugs for model engines are manufactured in a variety of heat ranges, and a plug should be chosen that is compatible with the fuel being used.

For Formula I racing, we have had the most consistent success using the Electrocone (Hobby Products #103). Fox Heavy Duty or K&B-1-L plugs. Other plugs have shown a tendency to blow the plug seal or burn out the element under severe racing conditions.

In the FAI event, the colder fuel requires a hotter plug and for this purpose we have found the K&B-1L or K&B Idle Bar plugs to give good performance.

The Propeller – Of all the accessories necessary for racing, the propeller is probably the least understood. This stems from the fact that reliable testing conditions are difficult to set up with the many variables existent in flying the race course. The drag and weight of the airplane, the engine performance, and flier's technique will all have a bearing on the optimum propeller selection.

We can, however, make a few statements of fact which will aid the reader in selecting the best propeller for his airplane.

1. The engine must run close to its peak horsepower rpm in flight in order to obtain the most power. Using the graph in Figure 1, one can see that the higher the rpm goes, the more power that is obtained up to a point.
2. A low-pitched prop will accelerate faster and have a slower top speed than a high-pitched prop.
3. A large diameter prop is more efficient than one of smaller diameter.

From these statements, it can be seen that the airplane, engine, and propeller must be matched to each other in order to gain maximum performance. So the object of the game is to find the right combination to do the job. Only a stop-watch and some very consistent flying can give the ultimate answer, but from past experience we can give the reader a few tips to save some time in the process of experimentation.

Most of the engines mentioned earlier will reach their peak horsepower at an in-flight rpm of about 21,000. Exceeding the peak horsepower rpm in flight will only decrease the life of the engine.

The engine will gain about 3,000 rpm in flight so the engine should be loaded to peak out at about 17,500 to 18,500 on the ground.

With this knowledge and the facts mentioned previously, the reader can experiment to find the best propeller for his airplane and engine. A good starting point is the engine itself. Take a Top-Flite 9 X 6 Super M maple propeller and cut it accurately to 7½ X 6. On 55% nitro a good engine will turn 21,000 ±500 rpm. This is equivalent to our desired inflight rpm. If the engine does not produce this desired rpm it should be inspected to find out why.

Experimentation has shown that the best prop for our Formula I racers will have 8½ to 9" diameter and 7 to 8½ inches of pitch.

Top flite models makes a series of propellers for Pylon racing of the proper pitch and diameter from hard maple stock. If the reader has a choice, he should select props that have the grain running parallel to the shaft hole and straight from end to end. This will guarantee that both blades will flex in the same manner. Rev-Up props of the Pylon type are also beginning to appear.

Choose several propellers with various pitches slightly longer than desired (9 to 9½ inches) and start your testing by progressively cutting down the diameter after each flight, (1/8 inch at a time) and noting the 10-lap time on the stop watch. After testing each pitch in this manner, it will soon become apparent which combination of pitch and diameter is best for your airplane. Consistent flying is of the utmost importance here.

After the best prop is found, the diameter and pitch should be measured accurately so that the prop can be duplicated exactly. For this purpose, a pitch gauge may be purchased or one can be constructed by cutting angle templates to match each ½ inch of radius on the propeller blade. A good pitch gauge is available from Prather Products.

With the above information the reader can get into the winner's circle if he is willing to devote the time needed to improve his flying skill and to work out the best engine/propellor combination for his airplane. We hope to see you there.

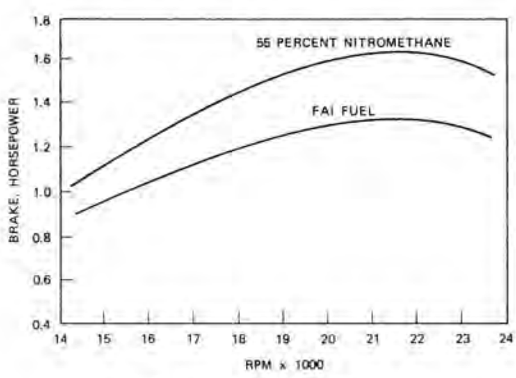


FIGURE 1. TYPICAL HORSEPOWER CURVE
0.40 CUBIC INCH RACING ENGINE

THE "ALKY BURNER"

by Bill Wisniewski

Bill Wisniewski

The engines used for FAI pylon racing have to be set up a little differently from the normal open exhaust engine used for Formula I racing. There are two factors involved: first, the engine must be fitted with a muffler of some kind, which causes back pressure to the engine, and second, the fuel used contains no power ingredients such as nitromethane. To overcome some of these disadvantages, the engine can be reworked to bring the performance back.

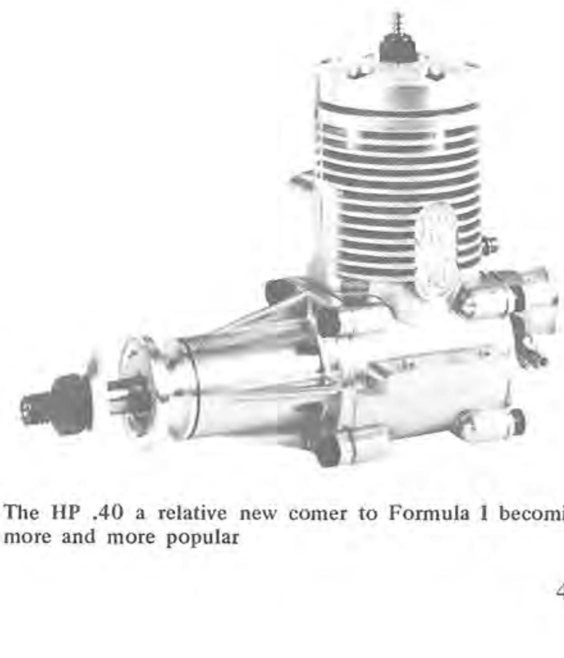
To overcome the back pressure, the port timing should be changed to allow more "blowdown time" between exhaust and intake ports in the sleeve. In other words, the difference between the two ports should be greater as measured from the top of the piston. This allows the exhaust gases to push more of the back pressure through the muffler before the intake ports open, thus allowing a fuller charge into the cylinder.

There are two ways to accomplish this: one is to raise 40% of the exhaust port .020 to .025; the other is to make a new sleeve with the intake ports lower by the same amount. There should be no "free port" i.e., no area open from the bottom of the piston to the bottom of the exhaust ports when the piston is at the top of its stroke. The free port would allow exhaust gases to dilute the fuel-air charge in the crankcase due to the back pressure in the muffler. A muffler should have as little back pressure as possible. There are some fairly good mufflers on the market and the lowest back pressure types are the flow through. It is a good idea to use a larger muffler than one that is too small.

Compression ratio is very important to the performance of an engine, especially the "Alky Burner." Compression ratio on most engines set up for "nitro" is around 7.5 to 1. This should be increased to 8.5 to 1 for engines set up to run on methanol and oil. (The compression ratio is the ratio of the volume in the cylinder at the point where the exhaust closes divided by the volume in the cylinder when the piston is at the top of its stroke.)

The most popular type head shape is the "squish band" head with 60-65% of the bore diameter in the combustion chamber. The squish band is the amount of material left. The squish band should be set at .004 to .008 from the piston top when the piston is at the top of its stroke.

Phil Greeno of England with his original design equipped with KDH retracts and HP engine. Plane was just as fast as Violett's Bobcat at 1971 International Pylon Meet.



The HP .40 a relative new comer to Formula I becoming more and more popular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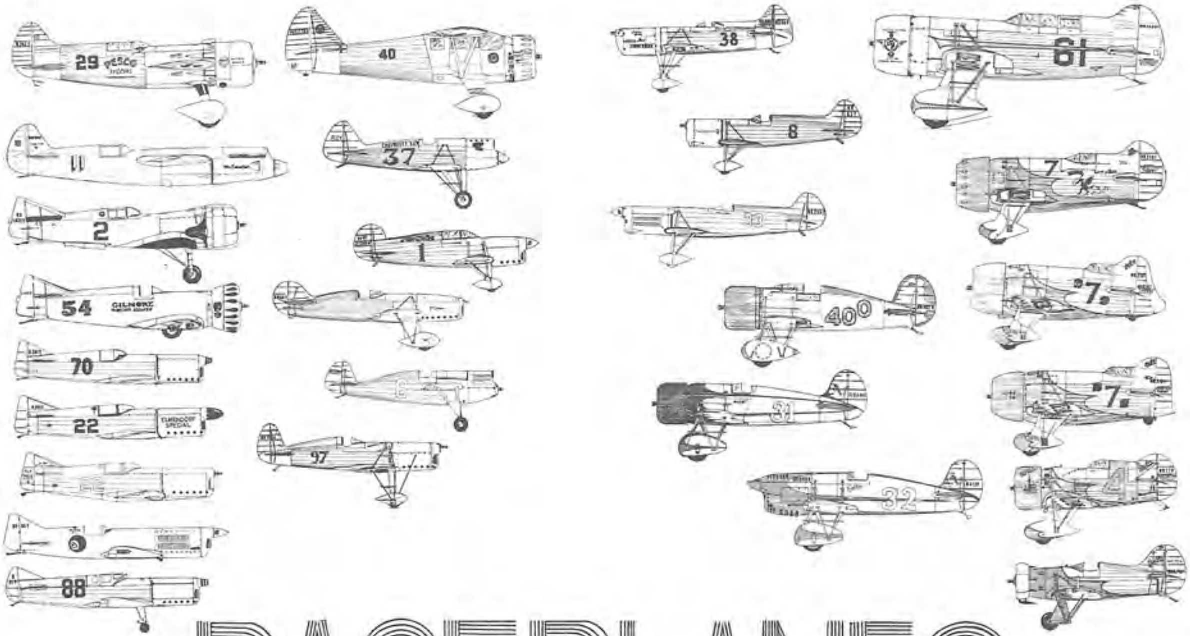

RACEPLANES

&

SCALE DRAWINGS

BY

R.S. HIRSCH
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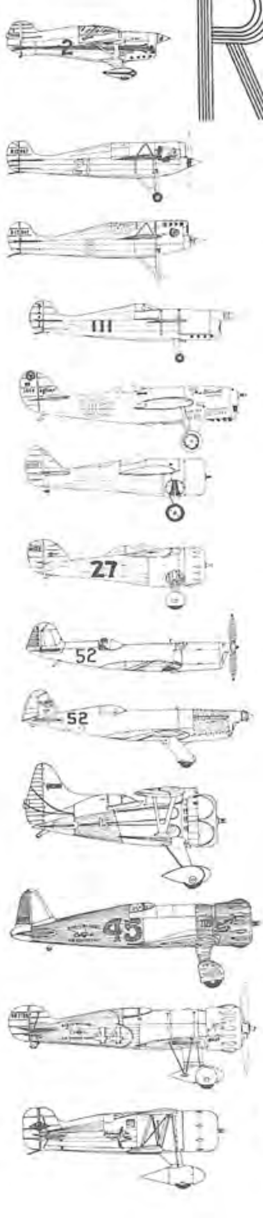
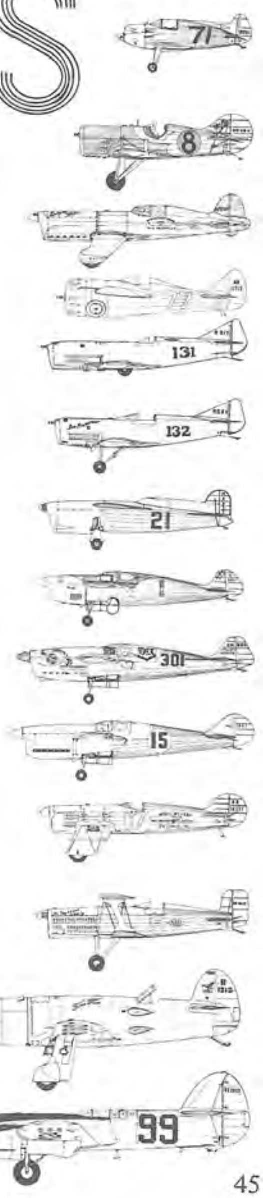
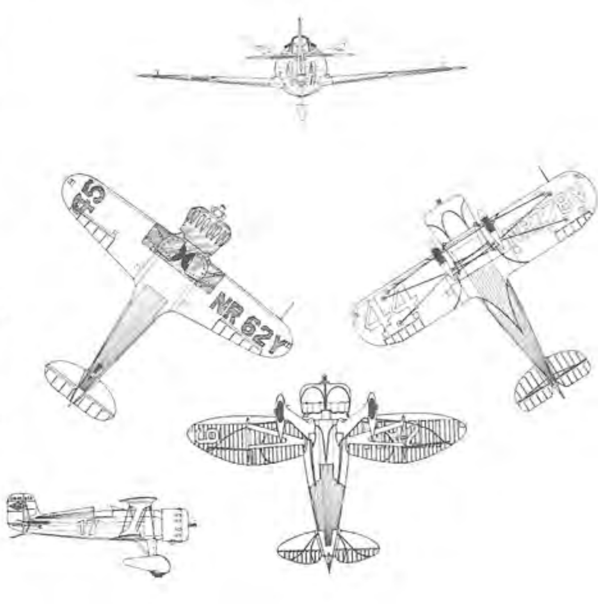
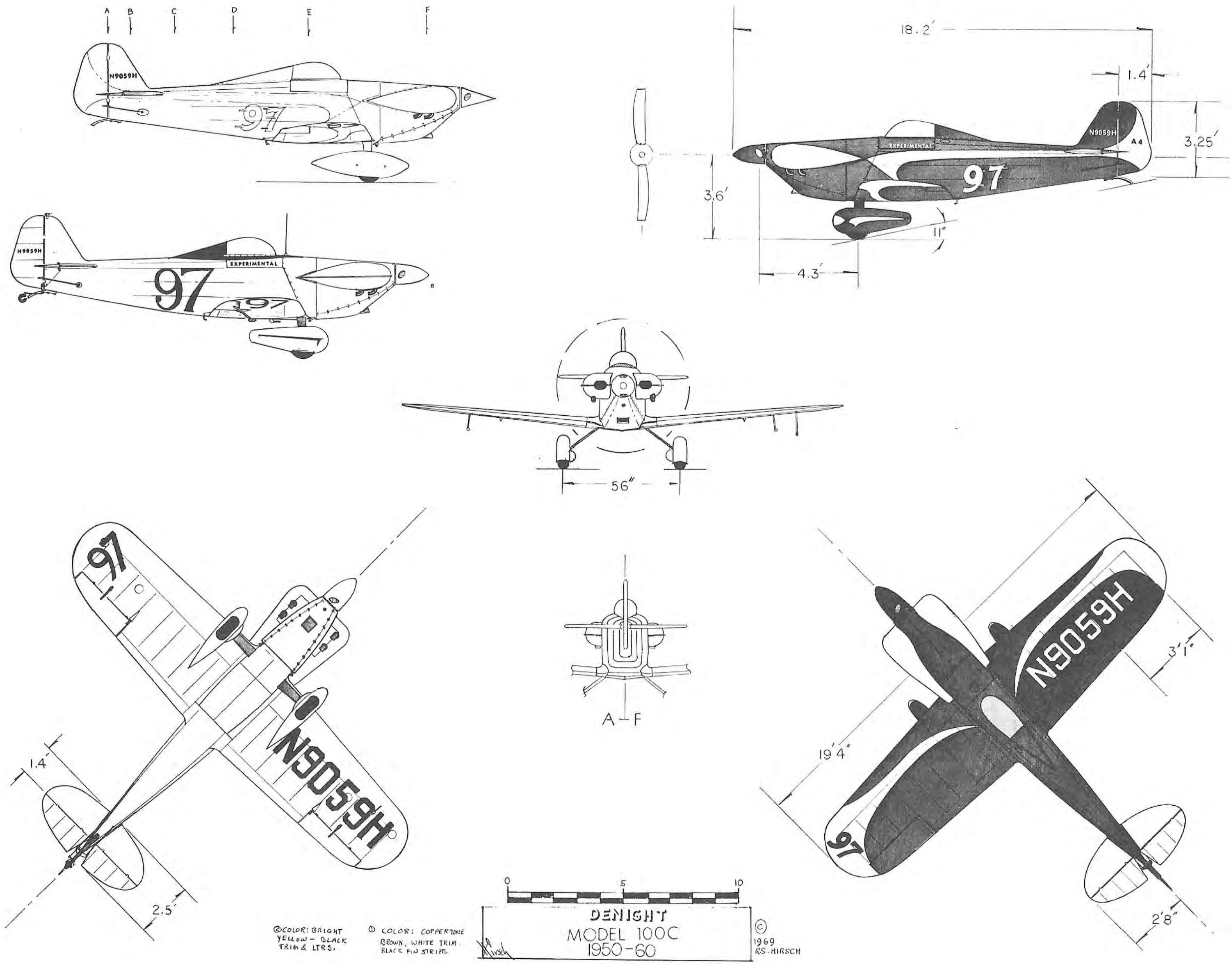
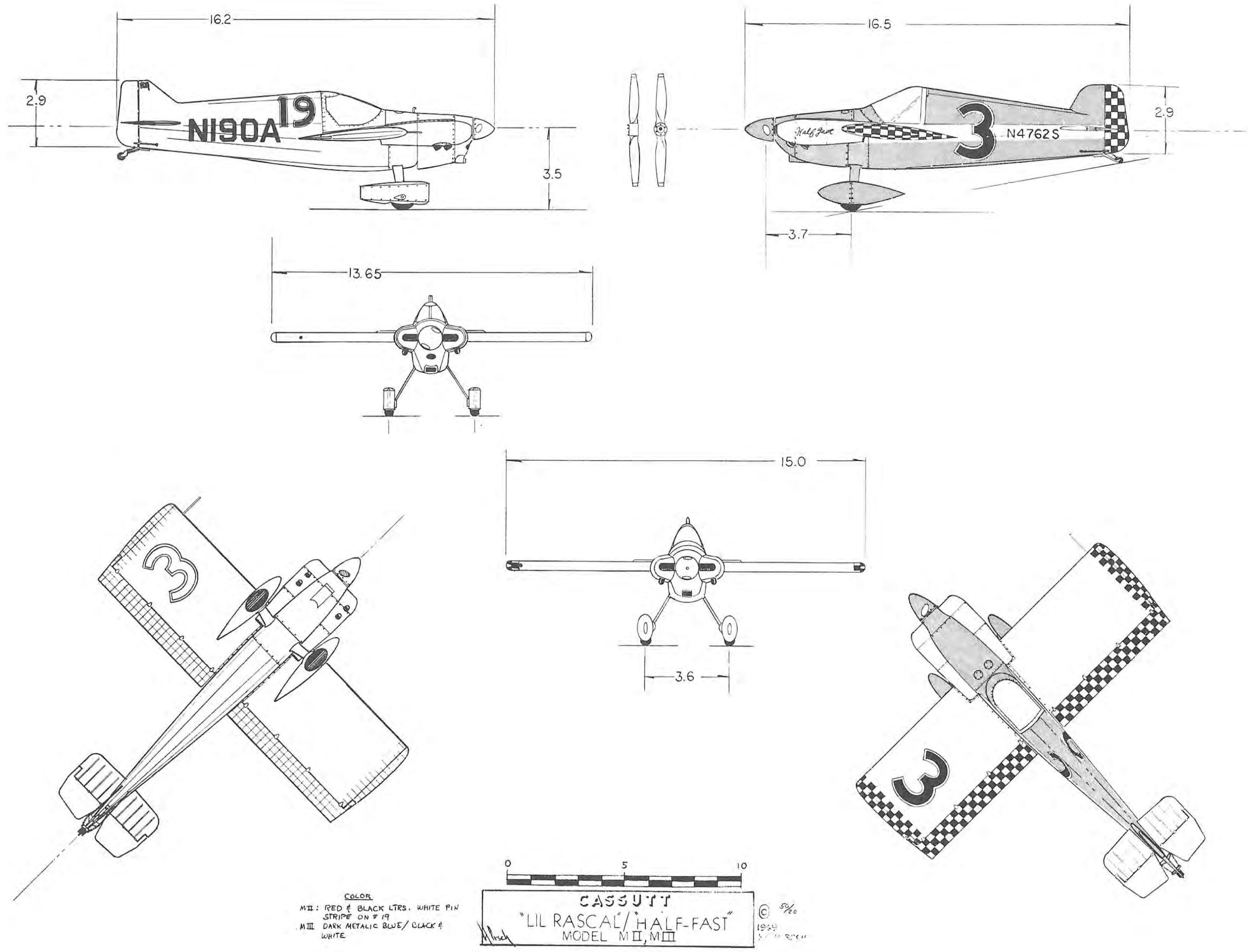
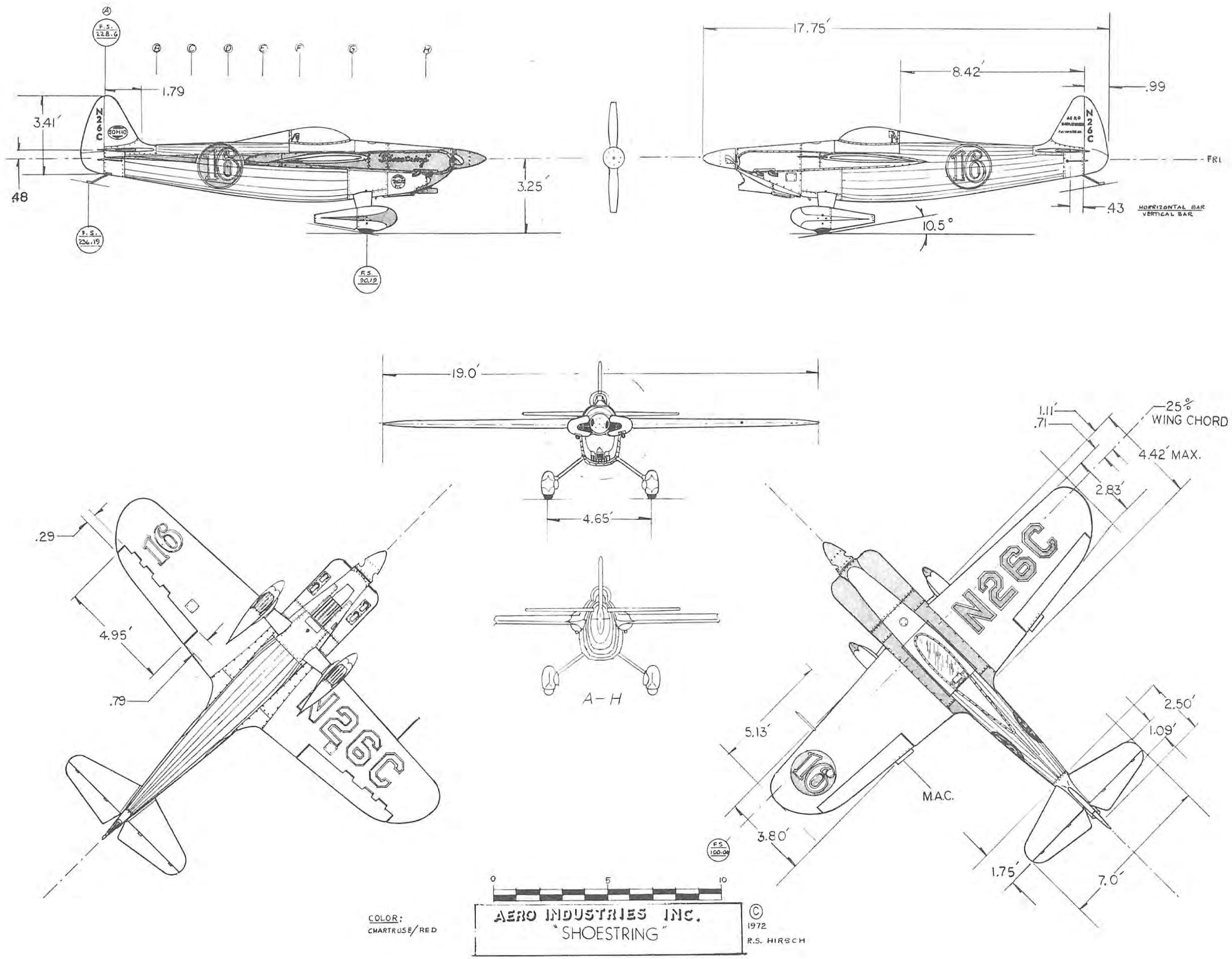







A B C D E F
N9059H
97
EXPERIMENTAL
18.2′
1.4′
3.25′
3.6′
4.3′
11°
A4
56″
A–F
1.4′
2.5′
3′1″
19′4″
2′8″
0 5 10
ⓔCOLOR: BRIGHT YELLOW – BLACK TRIM & LTRS.
① COLOR: COPPERTONE BROWN, WHITE TRIM. BLACK PIN STRIPE
DENIGHT
MODEL 100C
1950–60
© 1969 R.S. HIRSCH
Hirsch


16.2
2.9
N190A
19
3.5
16.5
2.9
Half-Fast
3
N4762S
3.7
13.65
15.0
3.6
3
3
0
5
10
COLOR
MII: RED & BLACK LTRS. WHITE PIN STRIPE ON # 19
MIII DARK METALIC BLUE/ BLACK & WHITE
CASSUTT
"LIL RASCAL"/"HALF-FAST"
MODEL MII, MIII
© 50/20



F.S. 228.6
1.79
3.41′
48
3.25′
F.S. 236.19
F.S. 90.19
17.75′
8.42′
.99
FRL
.43
HORIZONTAL BAR
VERTICAL BAR
10.5°
19.0′
4.65′
A–H
1.11′
.71
25% WING CHORD
4.42′ MAX.
2.83′
.29
4.95′
.79
5.13′
M.A.C.
3.80′
2.50′
1.09′
1.75′
7.0′
N26C
16
F.S. 100.08
0
5
10
COLOR:
CHARTRUSE/RED
AERO INDUSTRIES INC.
"SHOESTRING"
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1972
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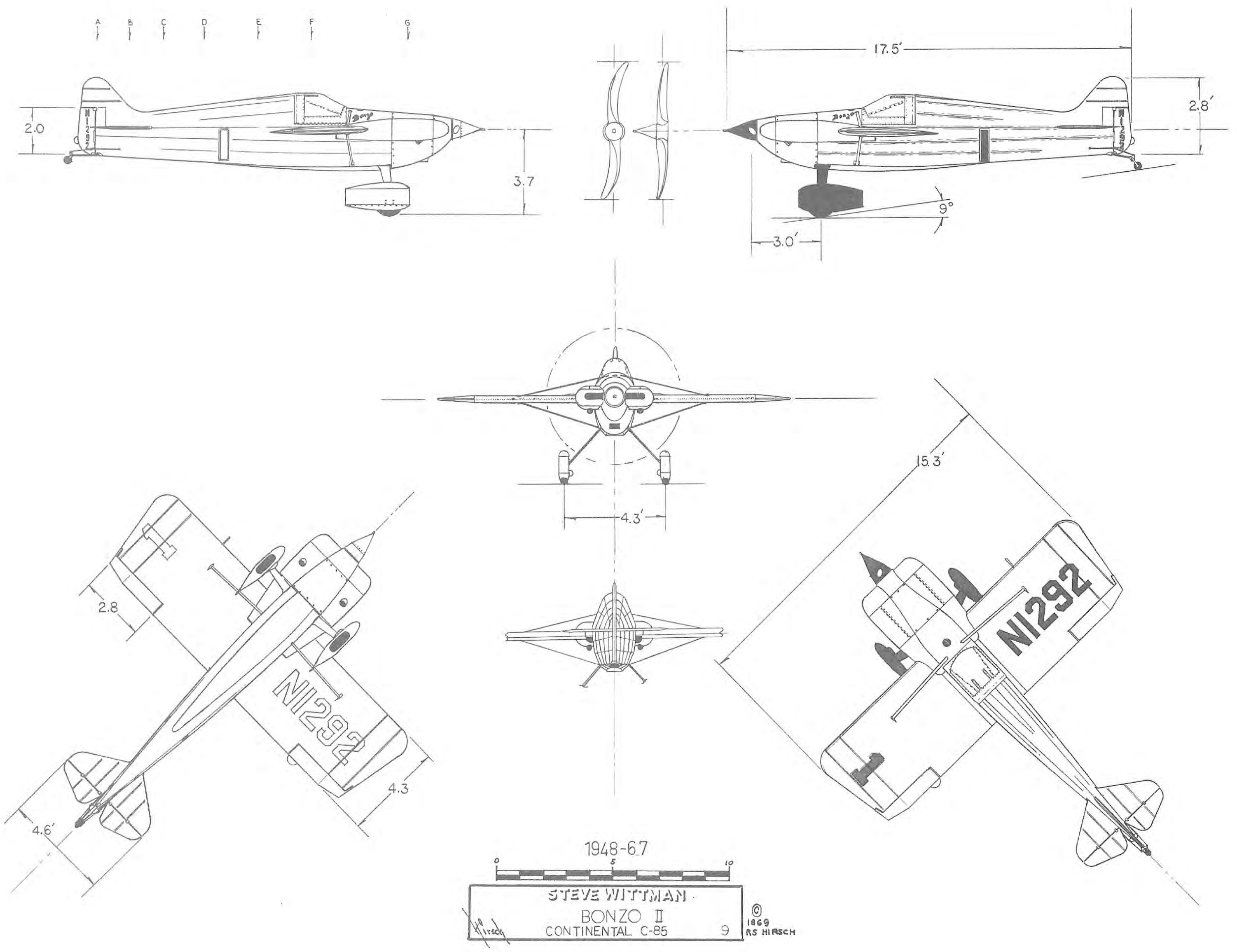
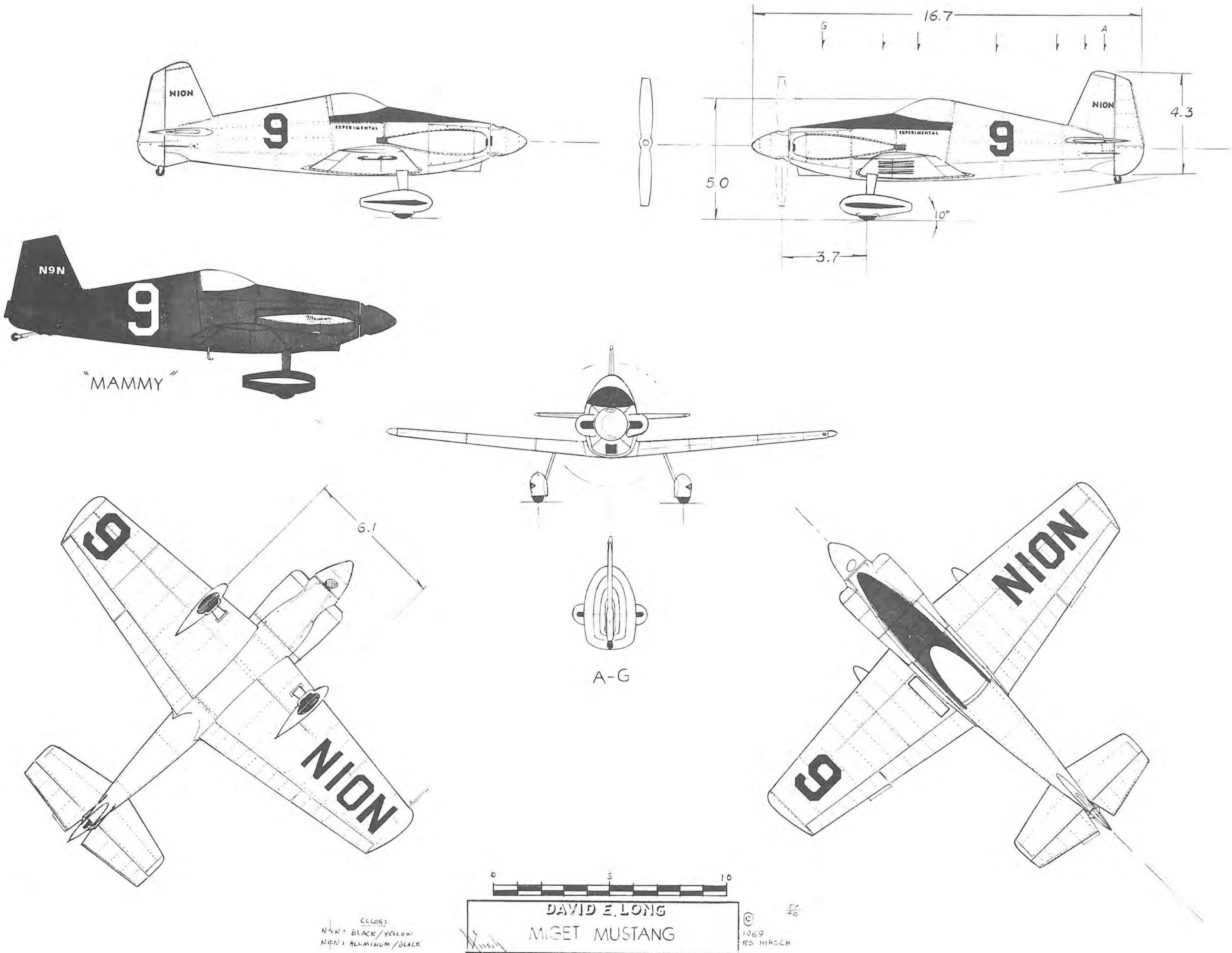
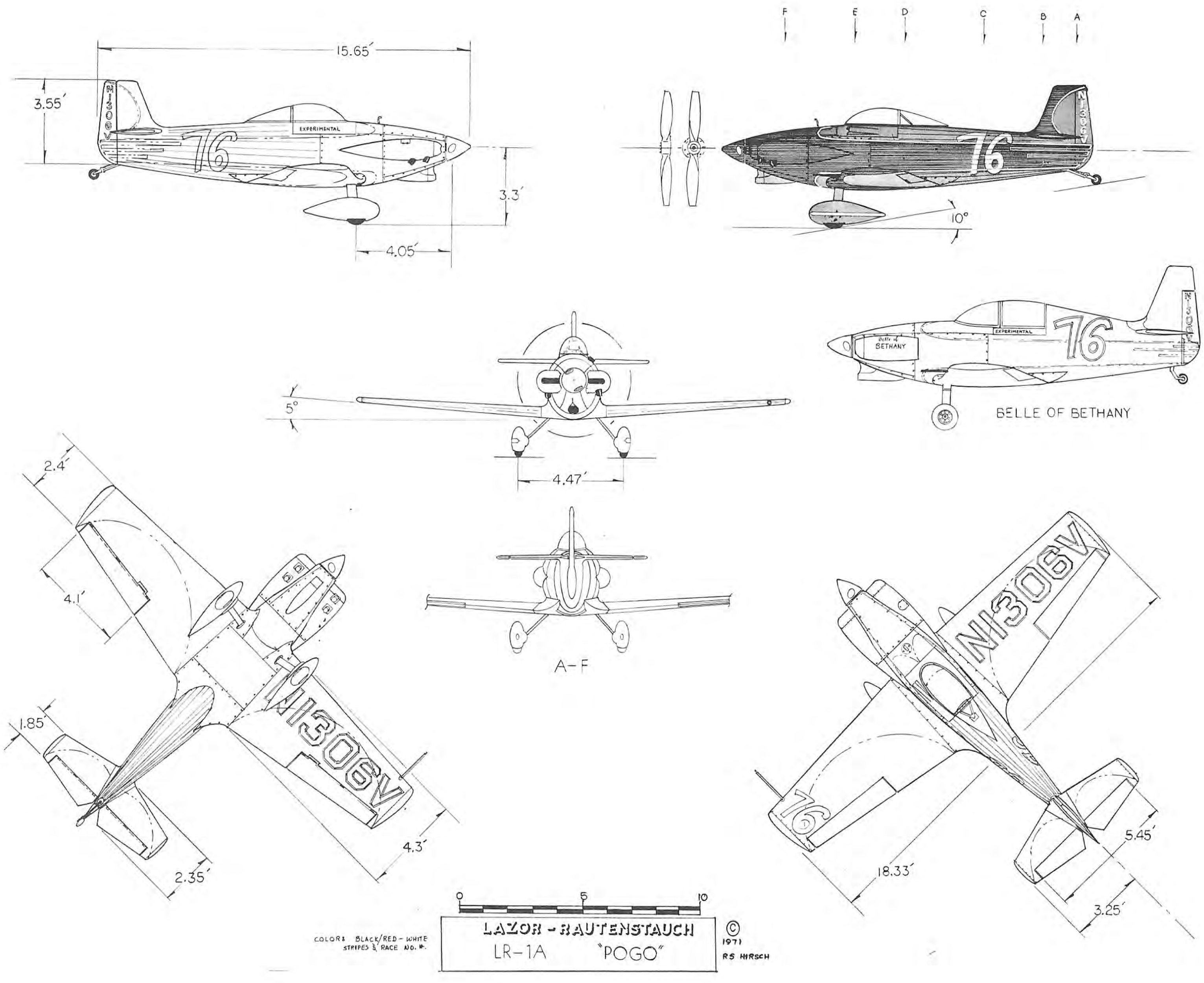

A B C D E F G
2.0
3.7
17.5′
2.8′
9°
3.0′
15.3′
4.3′
2.8
4.3
4.6′
N1292
Bonzo
1948-67
0 5 10
STEVE WITTMAN
BONZO II
CONTINENTAL C-85
9
© 1969 RS HIRSCH


16.7
G
A
NION
EXPERIMENTAL
9
4.3
5.0
10°
3.7
N9N
"MAMMY"
6.1
A-G
0
5
10
DAVID E. LONG
MIGET MUSTANG
© 1969 RS HIRSCH
COLOR:
N9N: BLACK/YELLOW
N10N: ALUMINUM/BLACK


15.65′
3.55′
3.3′
4.05′
EXPERIMENTAL
N1306V
76
F E D C B A
10°
5°
4.47′
Belle of BETHANY
BELLE OF BETHANY
A–F
2.4′
4.1′
1.85′
2.35′
4.3′
18.33′
5.45′
3.25′
0 5 10
COLORS: BLACK/RED-WHITE STRIPES & RACE NO. #.
LAZOR - RAUTENSTAUCH
LR-1A "POGO"
© 1971
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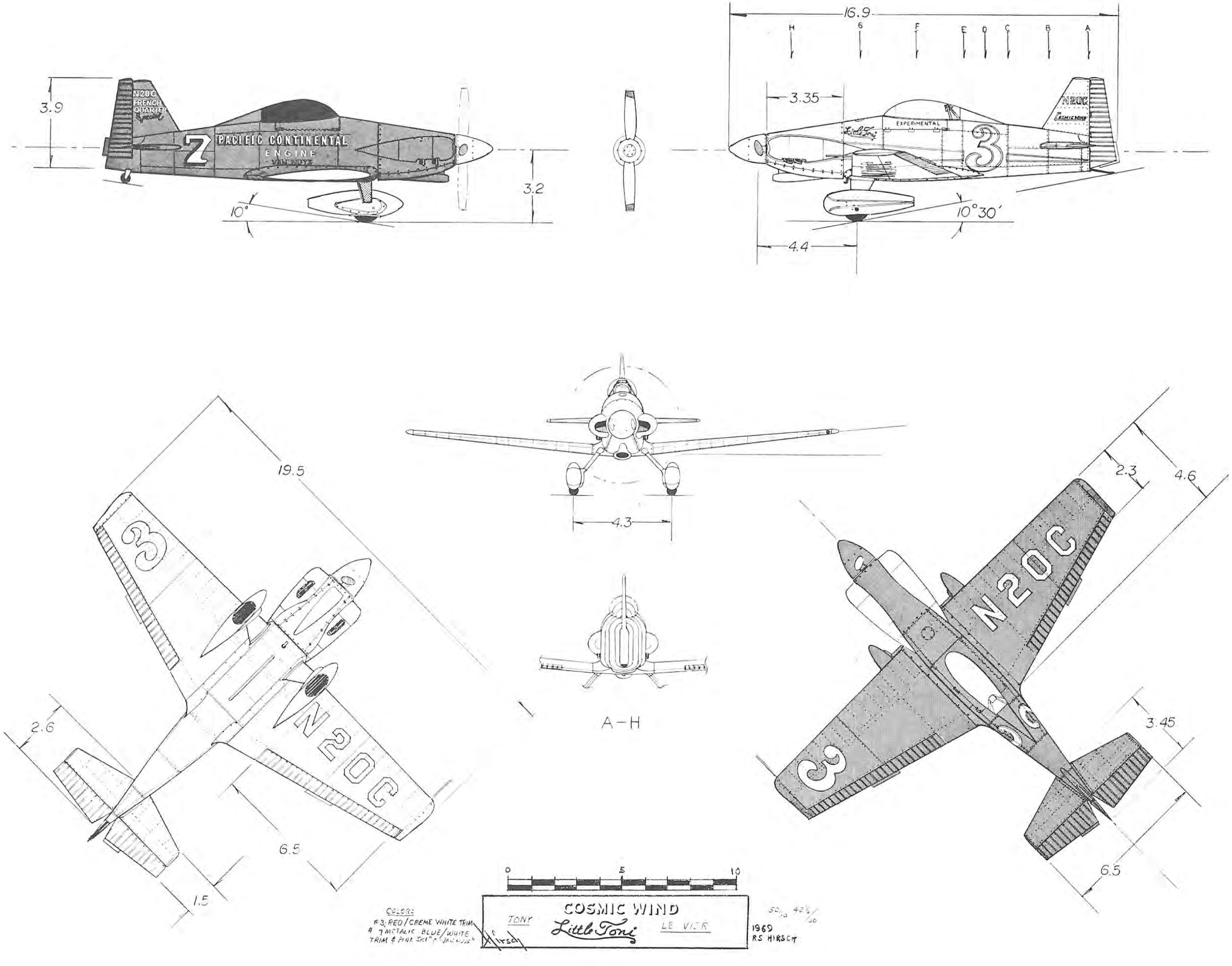
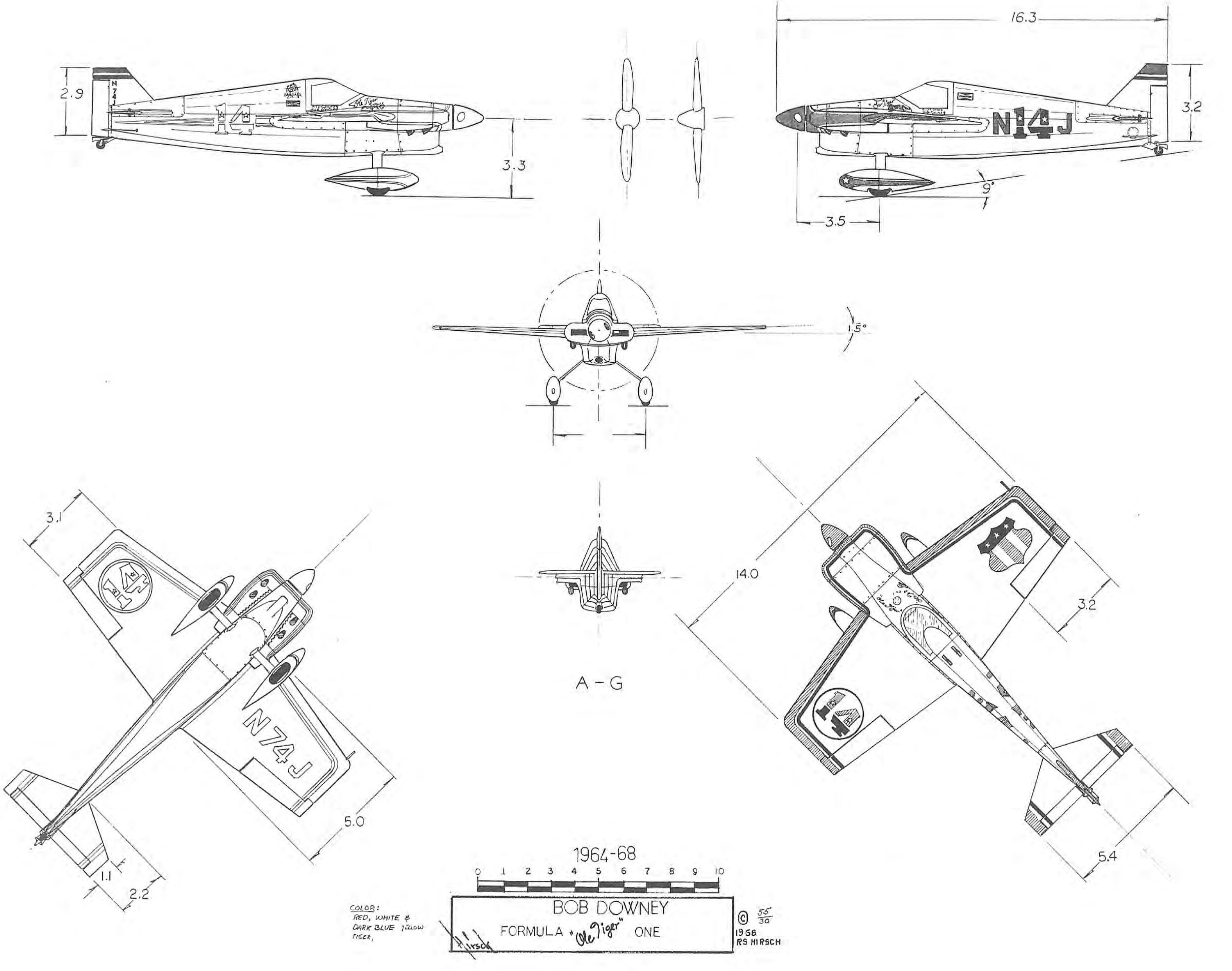


16.9
H
G
F
E
D
C
B
A
3.9
N20C
FRENCH QUARTER
PACIFIC CONTINENTAL
ENGINE
VAN NUYS
7
3.2
10°
3.35
EXPERIMENTAL
N20C
3
10°30′
4.4
19.5
4.3
2.3
4.6
A–H
2.6
3.45
6.5
1.5
6.5
N20C
3
0
5
10
COSMIC WIND
TONY
Little Toni
LE VIER
COLORS
#3; RED/CREME WHITE TRIM
#7 METALIC BLUE/WHITE TRIM & PINK SKI"
1969
RS HIRSCH


16.3
2.9
3.2
3.3
9°
3.5
1.5°
3.1
14.0
3.2
5.0
1.1
2.2
5.4
N74J
N14J
A - G
1964-68
0 1 2 3 4 5 6 7 8 9 10
BOB DOWNEY
FORMULA "Ole Tiger" ONE
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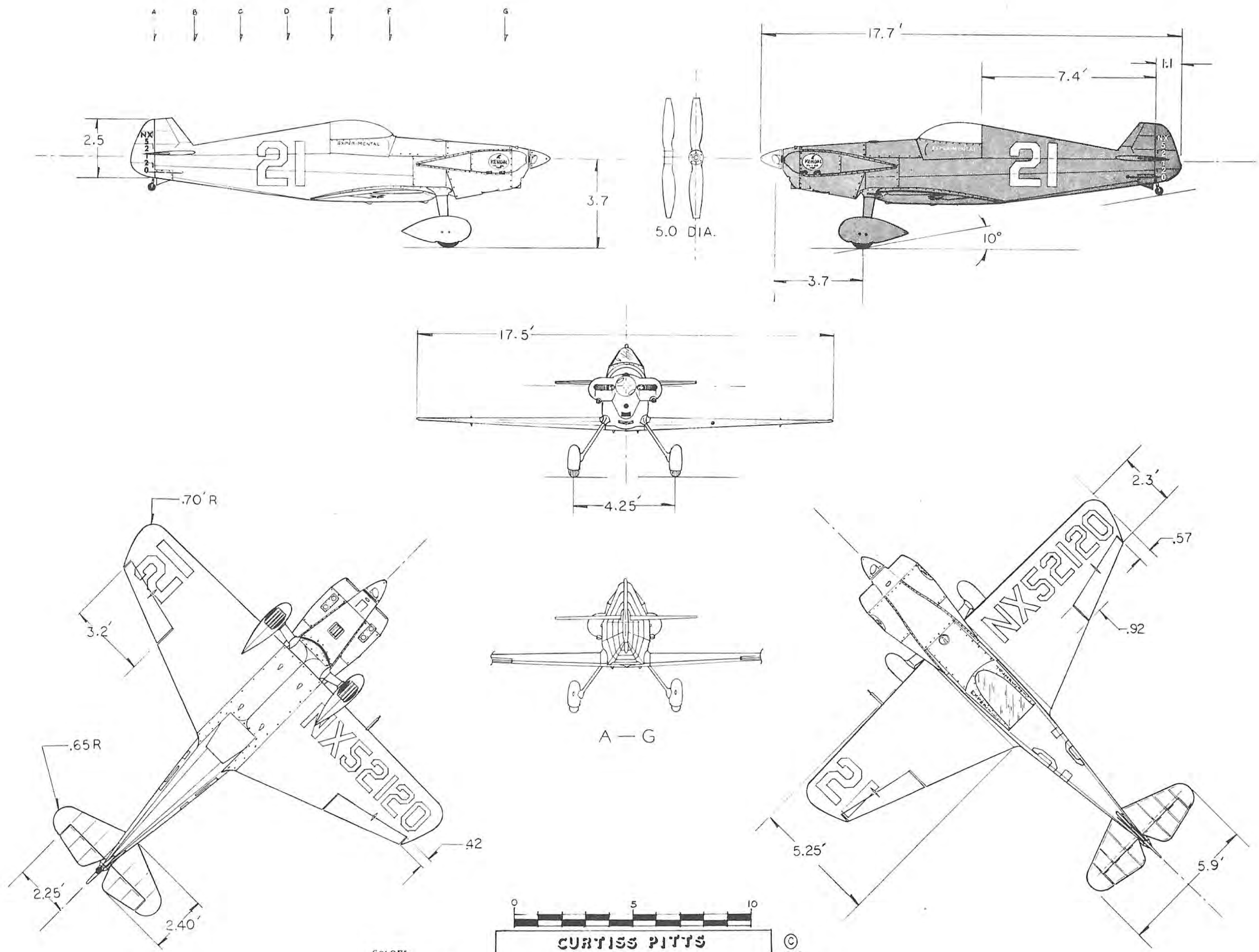
1968
RS HIRSCH
COLOR:
RED, WHITE &
DARK BLUE YELLOW
TIGER,



COLOR:
RED - WHITE LTRS. NO'S

CURTISS PITTS
"PELLET"
1948 1949

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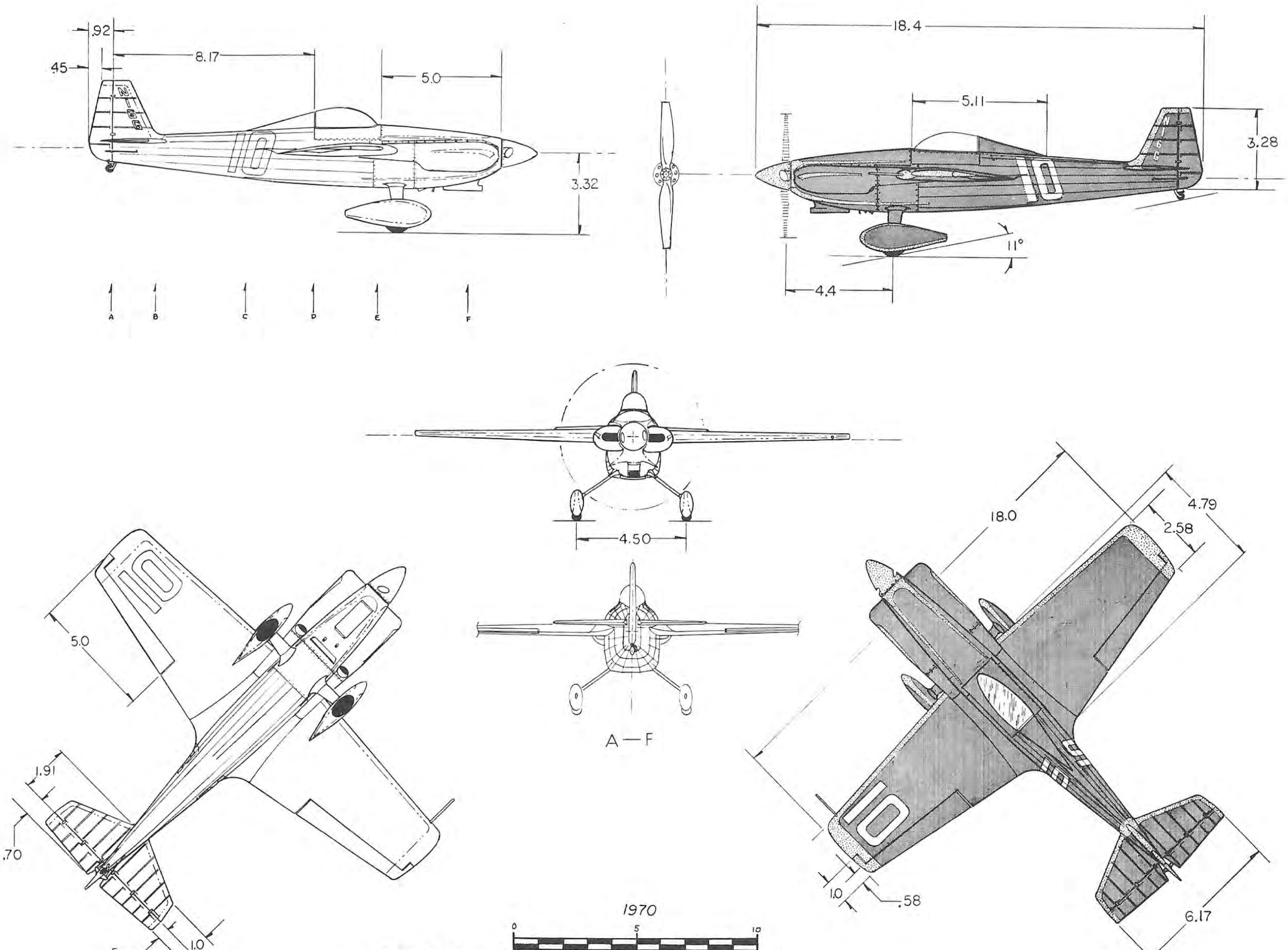
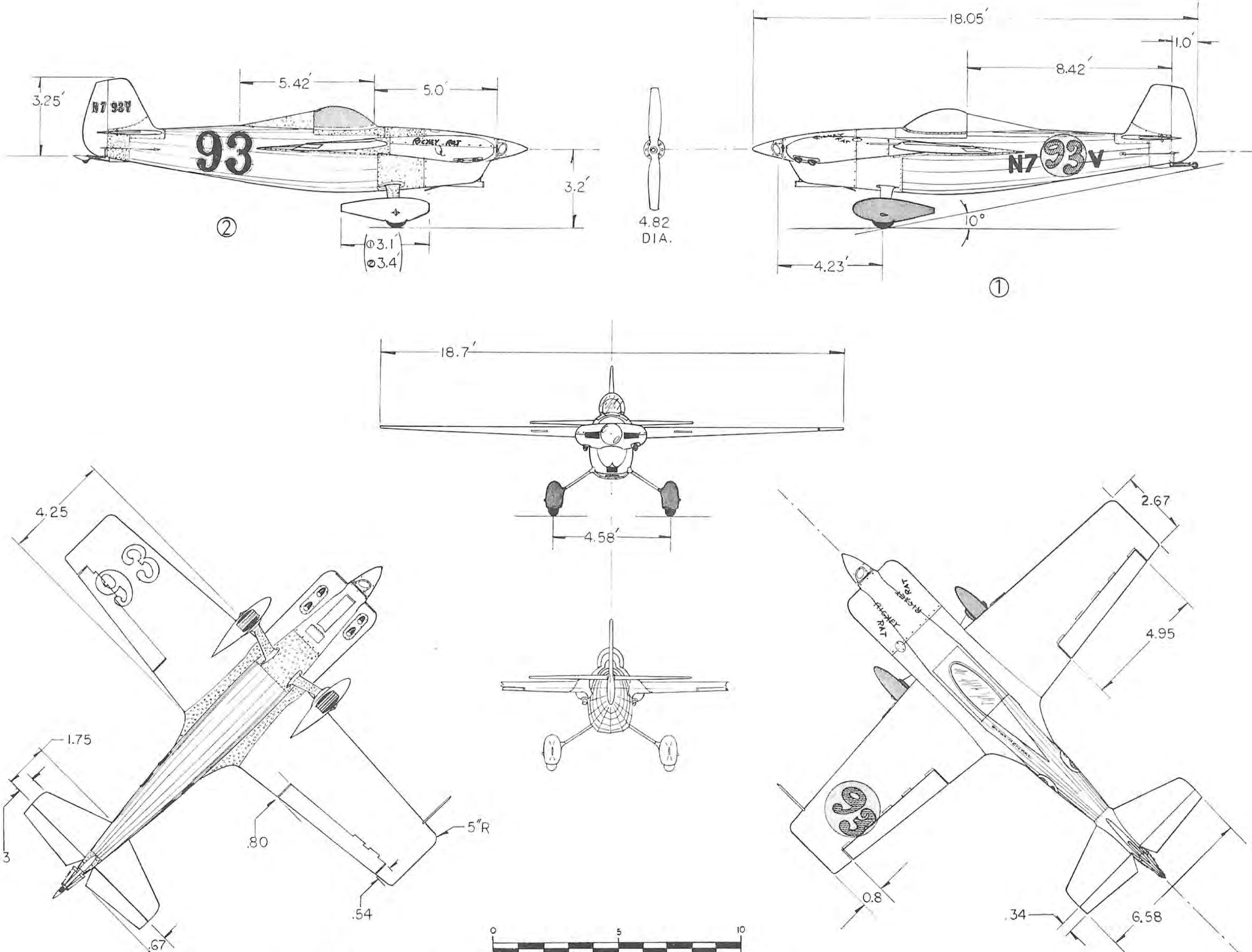


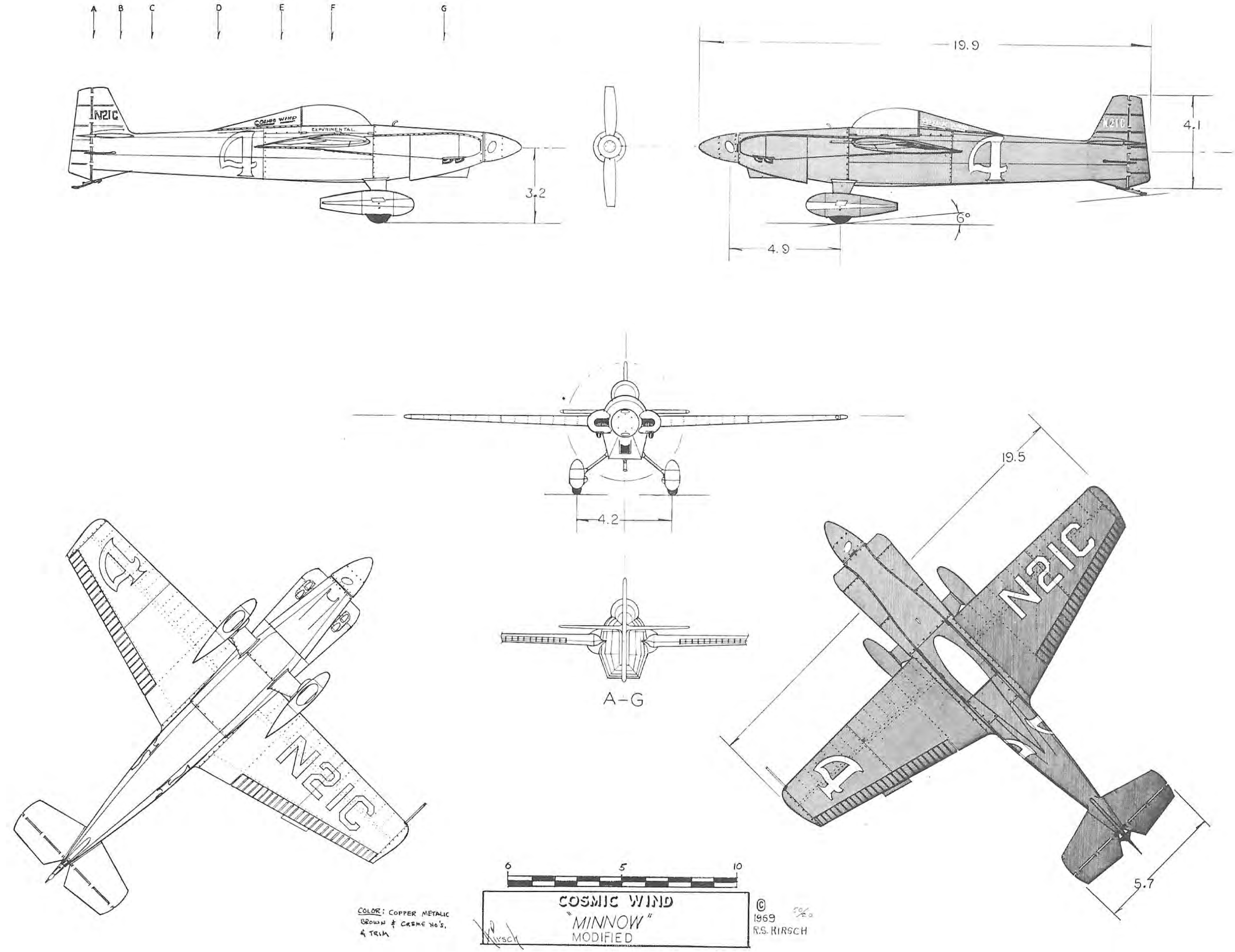
COLOR: RED/GOLD TRIM
WHITE NO. 10 &
PIN STRIPE

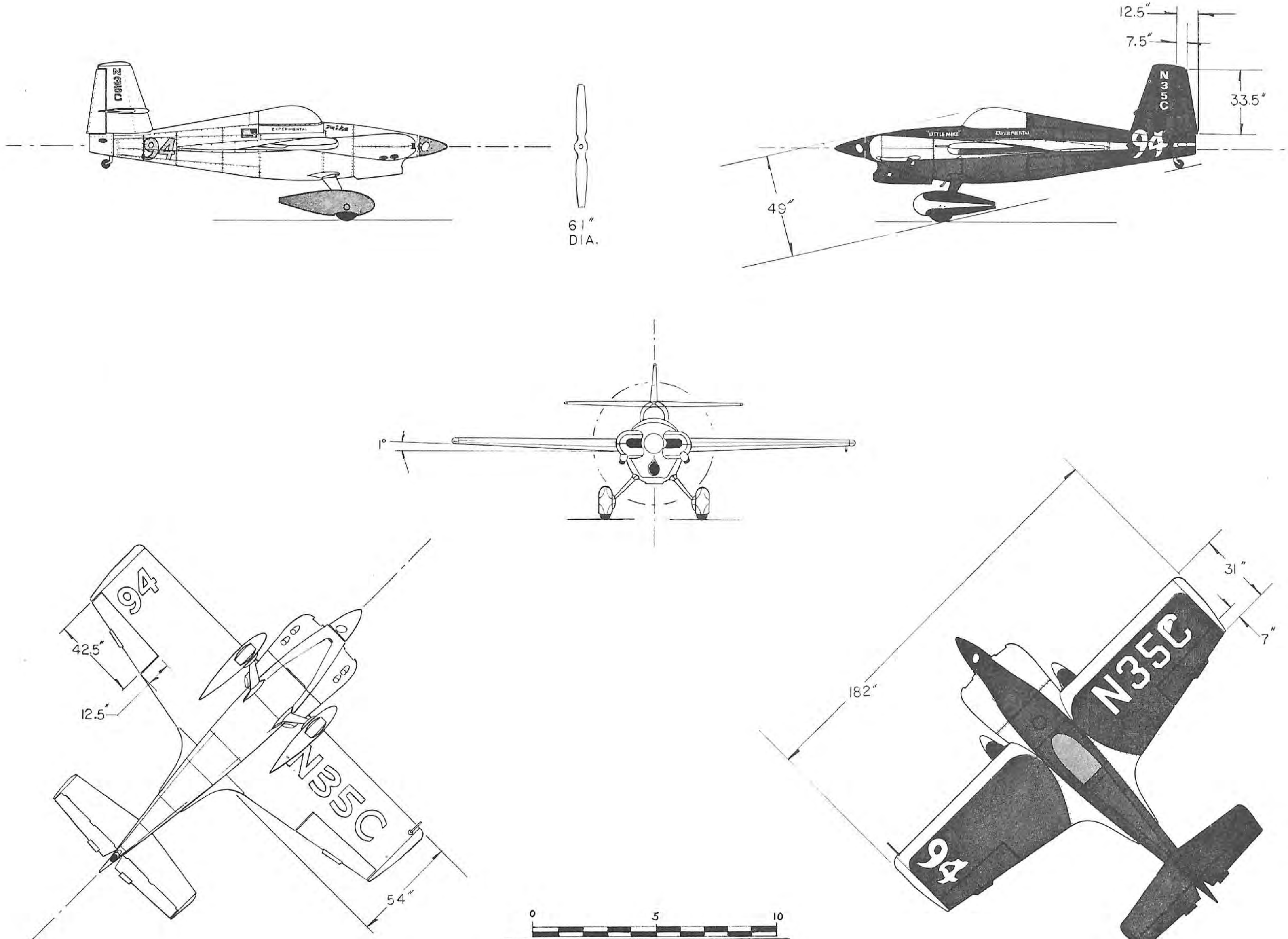
SLEEK FRENZEL
"EL BANDITO"



COLOR:
① 1970 – SILVER – BLUE #93 AND PANTS – YELLOW CIRCLE – BLACK N7 V
② 1971 – SILVER – BLACK 93 & WHITE PIN STRIPE BOARDERS.

VINCE DE LUCA
1970 RICKEY RAT 1972

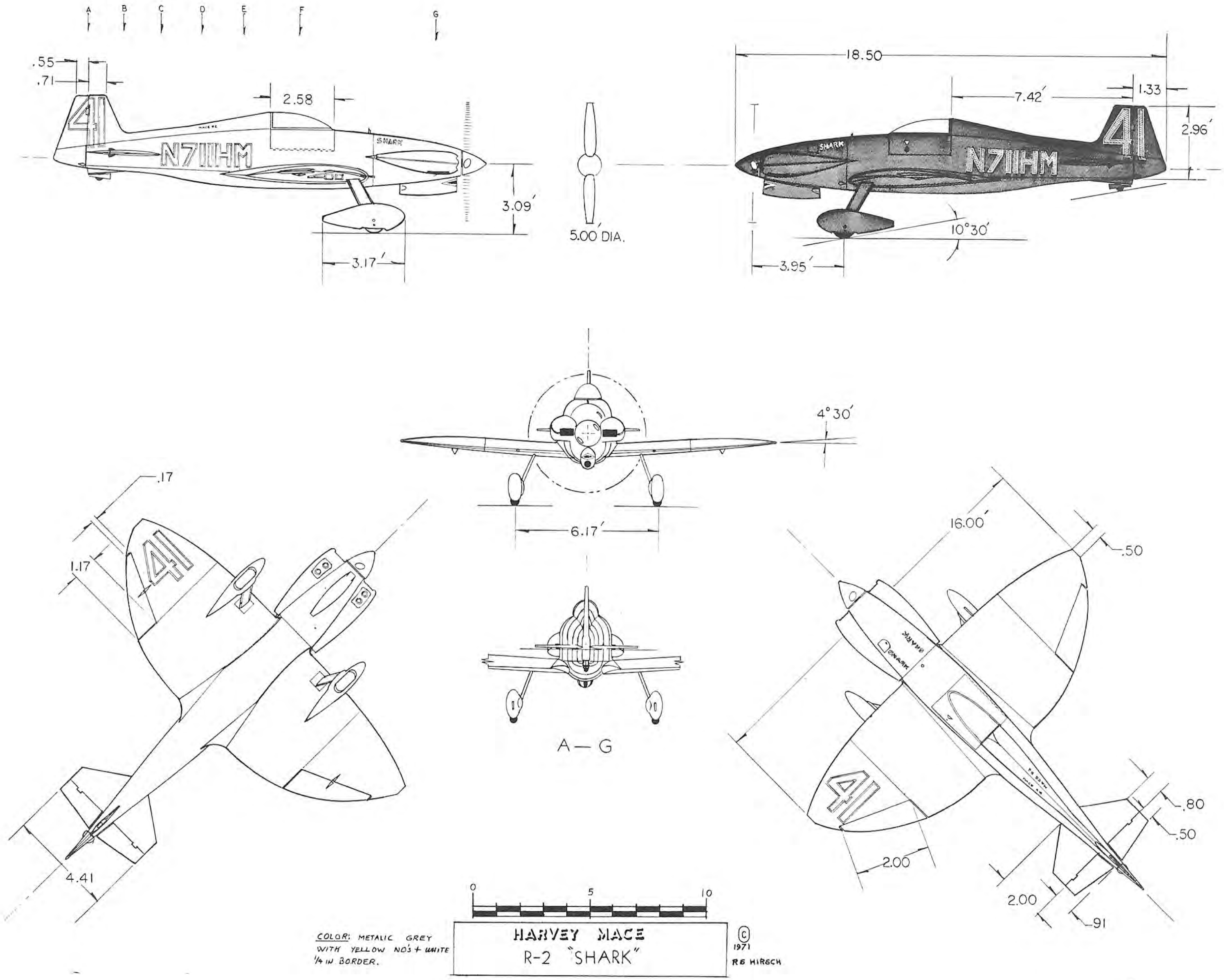

A B C D E F G
19.9
4.1
3.2
6°
4.9
19.5
4.2
A–G
5.7
N21C
0 5 10
COSMIC WIND
"MINNOW"
MODIFIED
© 1969 R.S. KIRSCH
COLOR: COPPER METALIC BROWN & CREME NO'S. & TRIM

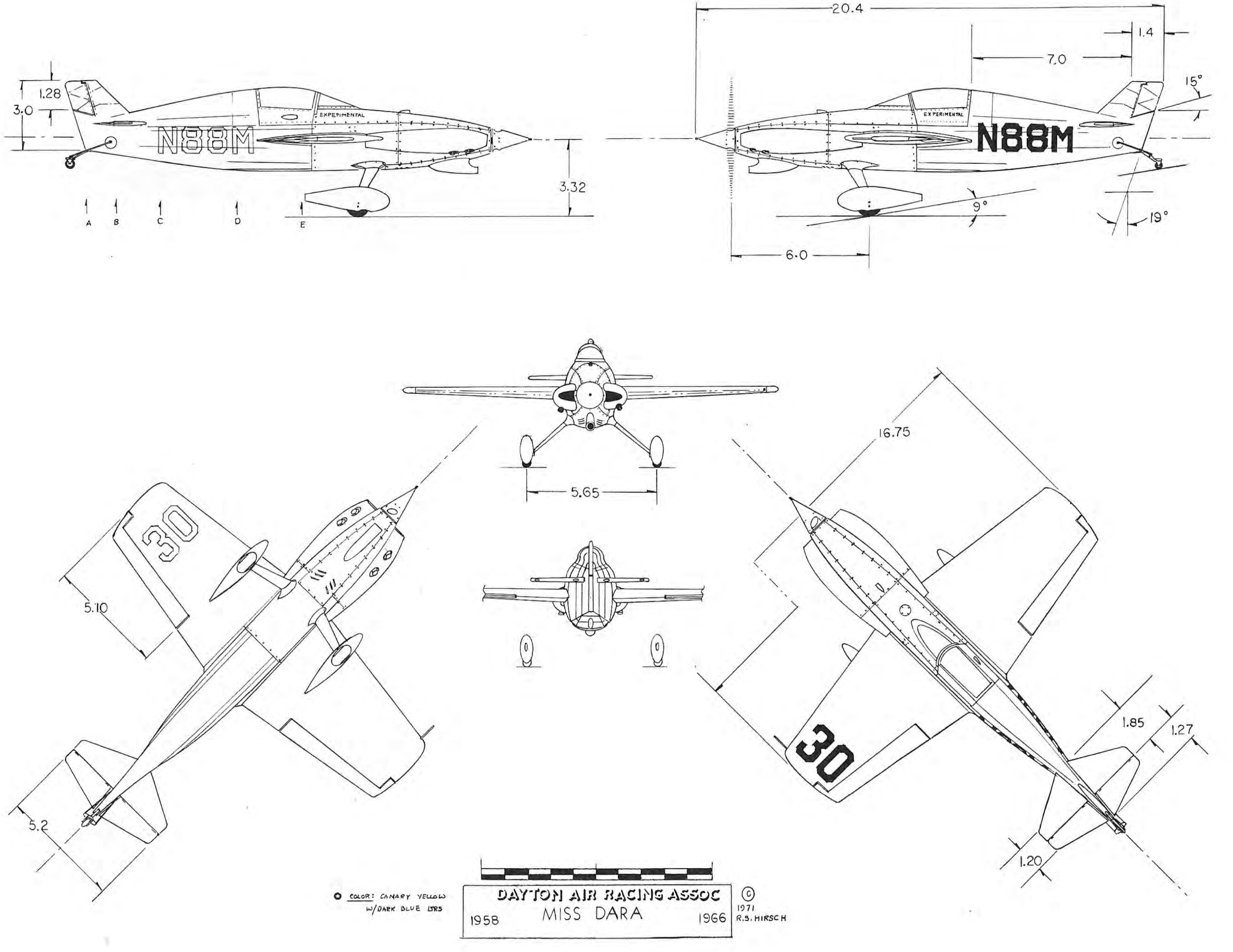


COLOR

1. DARK BLUE/WHITE TRIM & NO'S
2. WHITE/LIGHT BLUE TRIM, GOLD NO'S

AL FOSS
"LITTLE MIKE"
MIKE DEWEY


A
B
C
D
E
F
G
.55
.71
2.58
SHARK
N711HM
41
3.09′
3.17′
5.00′ DIA.
18.50
7.42′
1.33
2.96′
10°30′
3.95′
4°30′
6.17′
A— G
.17
1.17
4.41
16.00′
.50
.80
.50
2.00
2.00
.91
0
5
10
COLOR: METALIC GREY WITH YELLOW NO'S + WHITE 1/4 IN BORDER.
HARVEY MACE
R-2 "SHARK"
© 1971
RG HIRSCH


20.4
1.4
7.0
1.28
3.0
15°
EXPERIMENTAL
N88M
3.32
9°
19°
A
B
C
D
E
6.0
16.75
5.65
30
5.10
1.85
1.27
5.2
1.20
COLOR: CANARY YELLOW W/DARK BLUE LTRS
DAYTON AIR RACING ASSOC
1958
MISS DARA
1966
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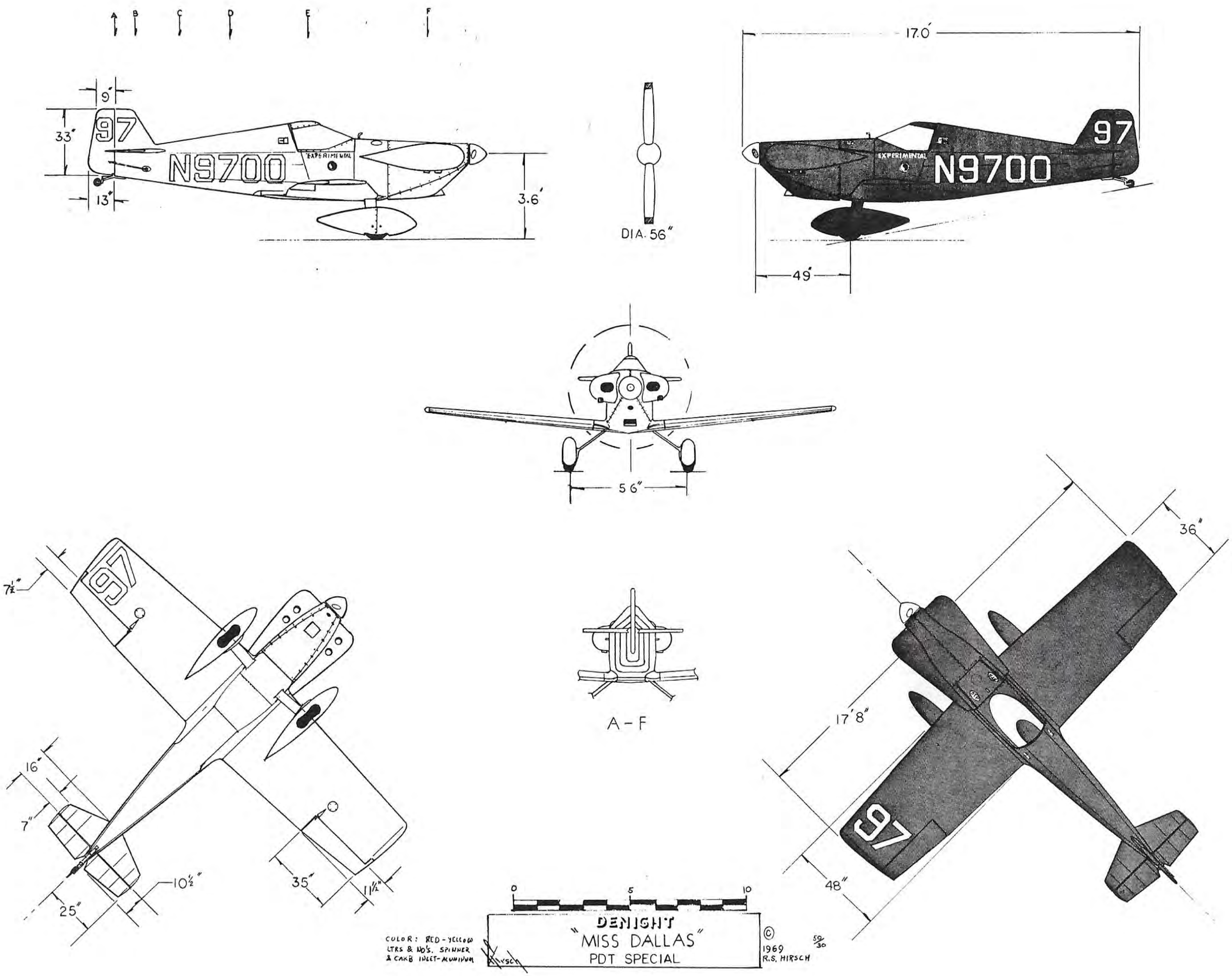

A B C D E F
9"
33"
13"
97
N9700
EXPERIMENTAL
3.6'
DIA. 56"
17.0'
49"
56"
A – F
7½"
16"
7"
10½"
25"
35"
11¼"
36"
17'8"
48"
0 5 10
DENIGHT
"MISS DALLAS"
PDT SPECIAL
COLOR: RED-YELLOW
LTRS & NO'S. SPINNER
& CARB INLET-ALUMINUM
© 1969
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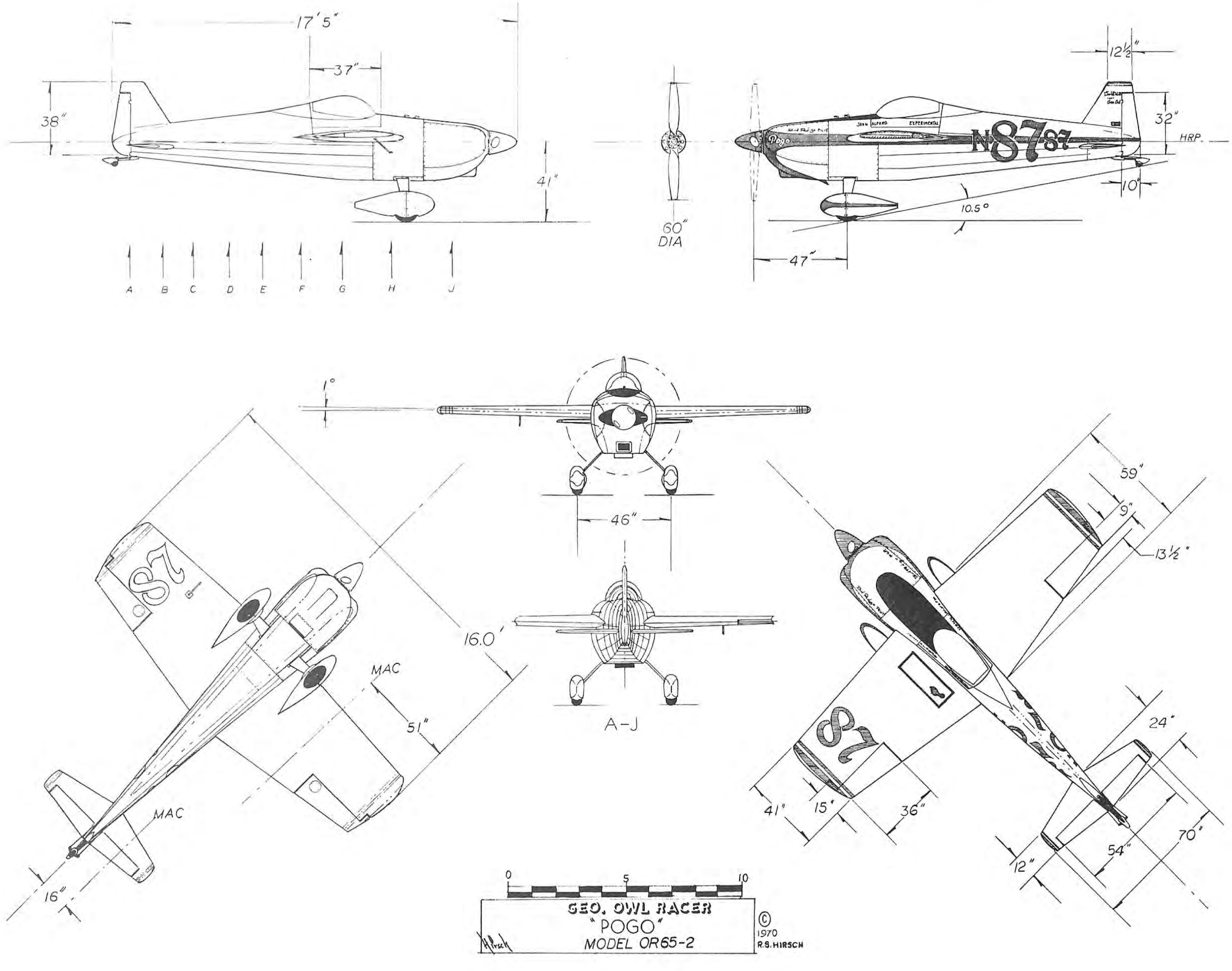
59/30



17'5"
37"
38"
41"
60"
DIA
12½"
32"
HRP
10"
10.5°
47"
A
B
C
D
E
F
G
H
J
1°
46"
A-J
16.0'
MAC
51"
MAC
16"
59"
9"
13½"
24"
41"
15"
36"
70"
54"
12"
0
5
10
GEO. OWL RACER
"POGO"
MODEL OR65-2
© 1970 R.S. HIRSCH

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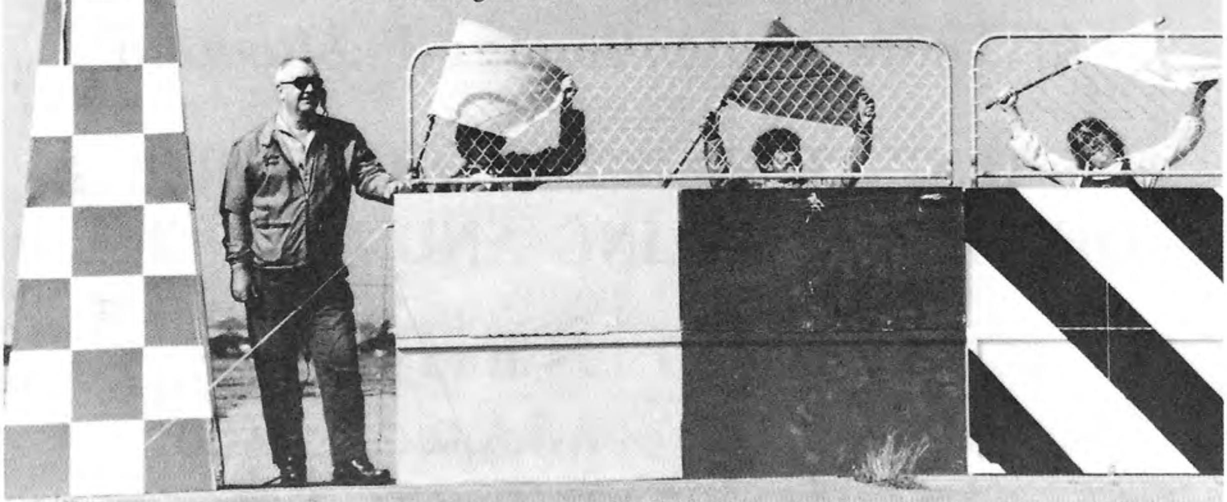

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Dick Tichenor squeezes in full size Little Mike Formula I racer with help of friend.

Cosmic Wind Little Toni (Minnow): One of the most popular R/C Formula I racers. This photo is of the full size racer.

Don Dombrowski from House of Balsa showing his Shoestring Quarter Midget racer.

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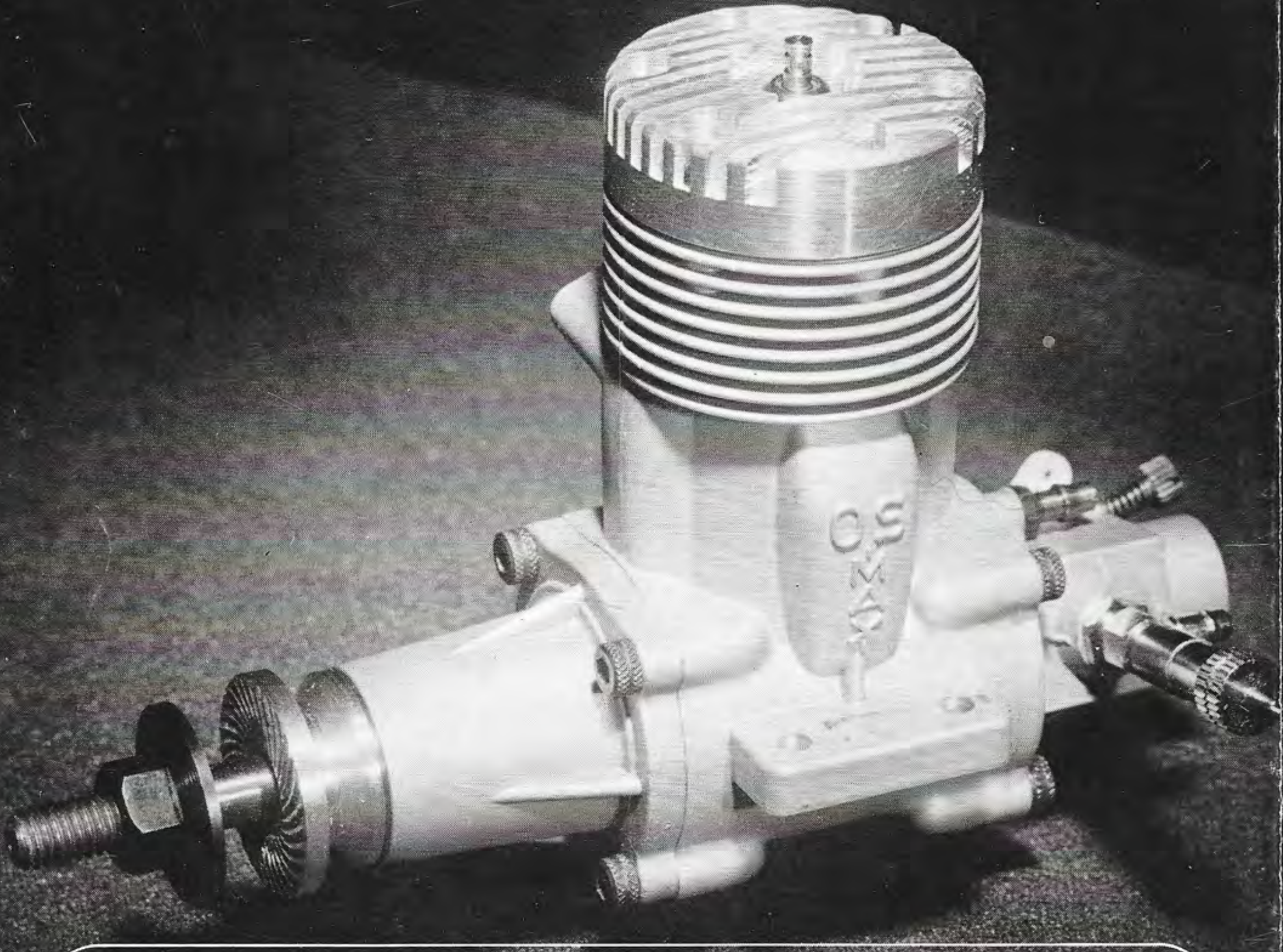
CALLING!!!

The art of calling the turns takes more concentration than many realize, note the expressions on the callers faces.

O.S. 40 R/C SCHNUERLE



The prototype of this engine—the one in the picture — was delivered in person by Mr. Ogawa of OS to World Engines September 1, 1973. The engine has some unique features. The Schnuerle porting is obvious. It is a side ported engine. The engine incorporates a drum valve instead of a disk-pressure fitting. The engine has a unique needle valve gasket to prevent blow by on the adjustable side of the needle which is sometimes encountered when you are running on pressure. Production engines will reach the United States in quantity in 1974. OS can and will meet the 1000 engine rule in the year of '74. The price of the engine around $70.00.

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