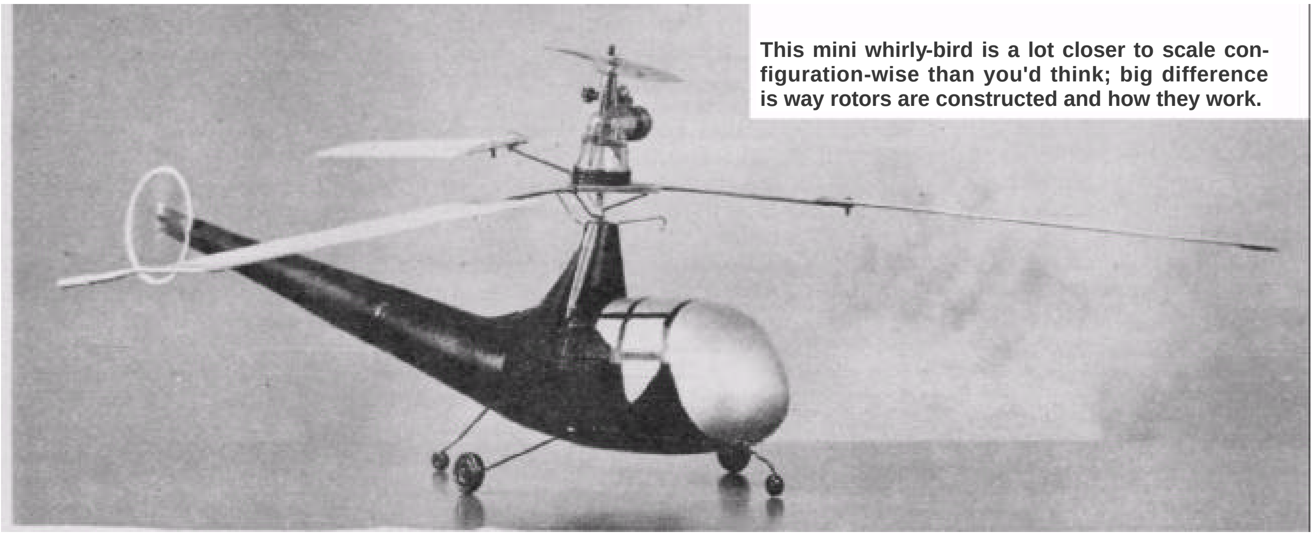
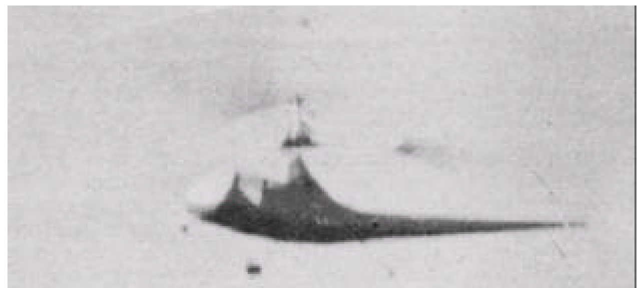


This mini whirly-bird is a lot closer to scale configuration-wise than you'd think; big difference is way rotors are constructed and how they work.

Semi-Scale Sikorsky R-6



In flight the model R-6 is a majestic sight. You'll really stop traffic with this one. Easy to build and a real thrill to fly as a free flight job.

One of history's most significant 'copters by one of modeling's most unorthodox designers; it's a mighty happy combo!

By ROY L. CLOUGH, JR.

•The Sikorsky R-6 helicopter is historically important for several reasons. As a design it marked the beginning of a trend away from unlovely steel-tube box structures, demonstrating that a helicopter could be beautiful as well as efficient. It was one of the first to be operationally fitted out as a flying ambulance— it could carry two external pods, each holding two stretchers on either side—and it took part in many early military experiments designed to test the utility and application of rotary wing craft.

The model R-6 follows in the historical tradition by introducing a new model helicopter rotor system, the "multi-phase rotor" which permits use of true mechanical cyclic control in addition to the automatic cyclic and collective pitch normally used in models.

The "multi-phase" rotor system is based on the idea that it is possible to build three distinct types of rotors which occupy the same space at the same time, so that the reactions of one rotor are modified by the others, etc. This is an extension of the co-axial system previously published in which one rotor was a rigid-feathering affair with the other a see-saw-feathering type, the interaction resulting in an automatically stable co-axial system. The multi-phase system uses three rotor blades, each with a different characteristic dynamic reaction. Thus we include the desirable features of each blade type, while suppressing the undesirable reactions in the composite meld.

(The reader should be cautioned that simply tossing together a number of different types of blades in one rotor is no guarantee that the good features will emerge and the bad features be suppressed—it can come out the other way around.)

For example: A rigid, non-feathering blade produces a nose-up resultant in forward flight, it does not autorotate; a Clough-type tip weighted blade produces a nose-down resultant in forward flight, and it autorotates beautifully; an angled hinge blade will tend to adjust pitching motions, it autorotates fairly well, but it is very critical in adjustment. In the multi-phase system we use the rigid blade to counter the nose-down tendency of the feathering blade (as in the Berkeley model D). What does the angled hinge blade do?

On this particular model we wanted to use a manually set cyclic control, which flips the feathering blade to produce forward flight by mechanical cycling, as in full scale, rather than by induced or C.G. shift cycling as is generally done in models. But, if we use a fixed cyclic deflection on the feathering blade, in conjunction with a fixed pitch stabilizing blade, we discover that as the speed of the model increases in forward flight we have two cyclic forces: first, the fixed mechanical cycling which will always be the same, and second, the dynamic cycling caused by air pressure on the entering edge of the rotor disk. This induced cycling increases with forward speed at about the same rate as the nose-up cycling effect produced by the fixed pitch blade; therefore, if we add mechanical cycling to it we find that the model will accelerate and go into a dive. We could prevent this by using larger fixed blades operating at greater pitch—but this would spoil the autorotation.

So we add an angled hinge blade to the system. This will autorotate, and as forward speed increases the air pressure in front of the disk causes it to bend downward and increase its pitch on the advancing side, and bend upward and decrease its pitch on the retreating side. Now we can pre-set the rotor system with a fixed amount of cyclic deflection on the feathering blade and the model will accelerate up to the point where the induced *reverse* cycling of the angle-hinge blade cancels out both the pre-set and induced cycling in the feathering blade and will go no faster. If air conditions, gusts, tend to speed up the model the rotor system increases it's cycling momentarily to kill off the speed, then resumes normal operations. If, in calm air, we launch the model sharply nose down, it slides forward, slows down, then finds its own optimum speed, and proceeds at that rate.

When the power stops the model descends in autorotation, the rate of descent being governed by the fixed pitch blade, which acts as a governor upon the two automatic blades. This incidentally does not produce a wobbling descent, provided any reasonable autorotational speed is maintained—90 rpm or a little better.

Construction

The model is a keel job; lay out and bulkhead in the usual manner. Note how the landing gear struts are cemented in position between blocks. Make sure these are dry before covering. The rotor mast should not be hard steel wire—use something fairly soft so it can be adjusted easily. The nose block goes on after covering. The covering may be 1/32" sheet balsa, or fairly stiff double-calendered paper miking about .008. If you use paper, start at the tail and work forward, lapping each joint 1/8" on the bulkheads. This paper covering trick produces an extremely smooth sheet-metal appearance and finishes with a minimum of doping, but it is slightly heavier. Whichever cover is used, note that the top area between bulkhead C and B must be covered before the pylon is sheathed in. This provides a working base to which to trim the pylon covering. Also be sure to cut a slot for the rear wheel strut.

The tail rotor is simulated by a plastic disk. Edge it with a circle of rattan or reed to keep its shape. It functions purely as keel surface. Cabin detail is painted on in a contrasting color—silver blue makes a good "glass"—and the front of the machine may be doped as much as desired since additional ballast will be needed in any event to balance the tail boom.

Before tangling with the rotor mechanism study the plan carefully. Sheet metal parts may be cut from tin can stock or secured from a Berkeley kit where applicable. The big idea here is to have everything tight that should be tight and freely-working on pivots and hinges. The rotor mast bearing should be very free, almost sloppy, but the pivots should work easily without any play for best results.

The rotor blades are very simple, and while you're at it make a couple of spares, just in case. Assemble the works and check the blade balance next. It won't ordinarily happen, but it is possible that the rotor assembly may balance perfectly by accident due to wood density variations. If this should happen, don't fly the model this way because a little extra mass is required on the tips of the fixed and angled hinge blades—about equal to a dime. If in the balancing operation more weight is required on the feathering blade with the tip weight, add this extra weight on the hinge line, not on the counterweight arm. Do not put the cyclic mechanism on yet.

The original model used a Wasp with its fuel tank modified as shown on the plans so it would operate without throwing fuel out of the vents.

Let's fly it. Check the C.G. location by holding the model sidewise by the engine shaft. If the tail dips down it is tail heavy and may dive; the best trial position is very slightly nose heavy or balanced on the mast axis.

Fire up the engine and make sure it is delivering full power before releasing the model—a ragged 2-4 cycling engine is poison. Release the model from a level position and *watch* it! If you have followed directions- closely the machine will rise up steadily, move forward very slowly and will probably circle rather tightly to the left—probably a bit tighter than you may desire, so bend the rotor mast slightly to the model's right, which will make it fly straight, or turn to the right, depending upon degree of bend. This, by the way, is your combined rudder-aileron control on this type model.

Fore and aft trim is accommodated by shifting the ballast—in reverse fashion, that is, more weight forward to kill off a dive, more weight aft to stop tail-sliding.

Once the trim settings are mastered the model can be flown that way if desired, but the cyclic control is more fun since it allows a choice of vertical ascent or horizontal flight at the flip of a lever (or more accurately, the bending of a wire!). Trim the model to rise vertically with a minimum of forward motion, then install the cyclic control. Simply cement a length of paper clip wire to the side of the pylon, as shown, and solder a short length of springy steel wire to the arm holding the feathering blade and blend it so the blade is flipped gently each revolution. Vary the position of the tripper by bending it up or down to regulate the cyclic deflection—not much is needed.

Now, with this control, and by varying the rotor tilt you can make it climb straight, fly forward, cruise in circles or any combination desired. Near-hovering can be obtained by cutting the fuel with a straight 3-1 mix of alky and castor oil.

. Guide to Helicopter Adjustment

Model helicopter flyers may find it easier to re-

Sikorsky R-6 built in 1943 was the first military high-performance helicopter. It would climb to 5000 ft. in 7 minutes, could carry bombs.

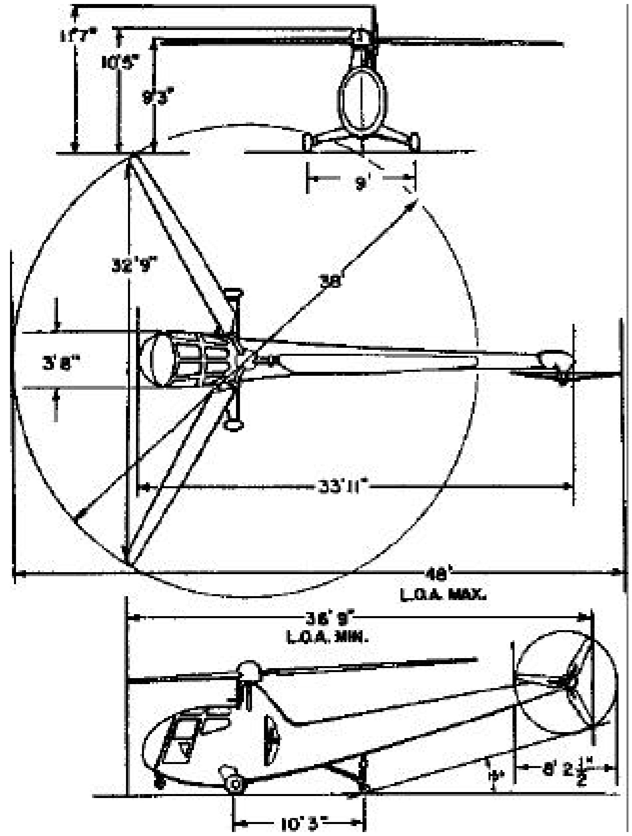
Glidden Doman of Doman Helicopters, Inc., used an R-6 to experiment with his dynamically balanced rotor system (no vibration).

The cabin ol the R-6 was built of molded plastic impregnated Fiberglass, probably the first use of this material in production aircraft.

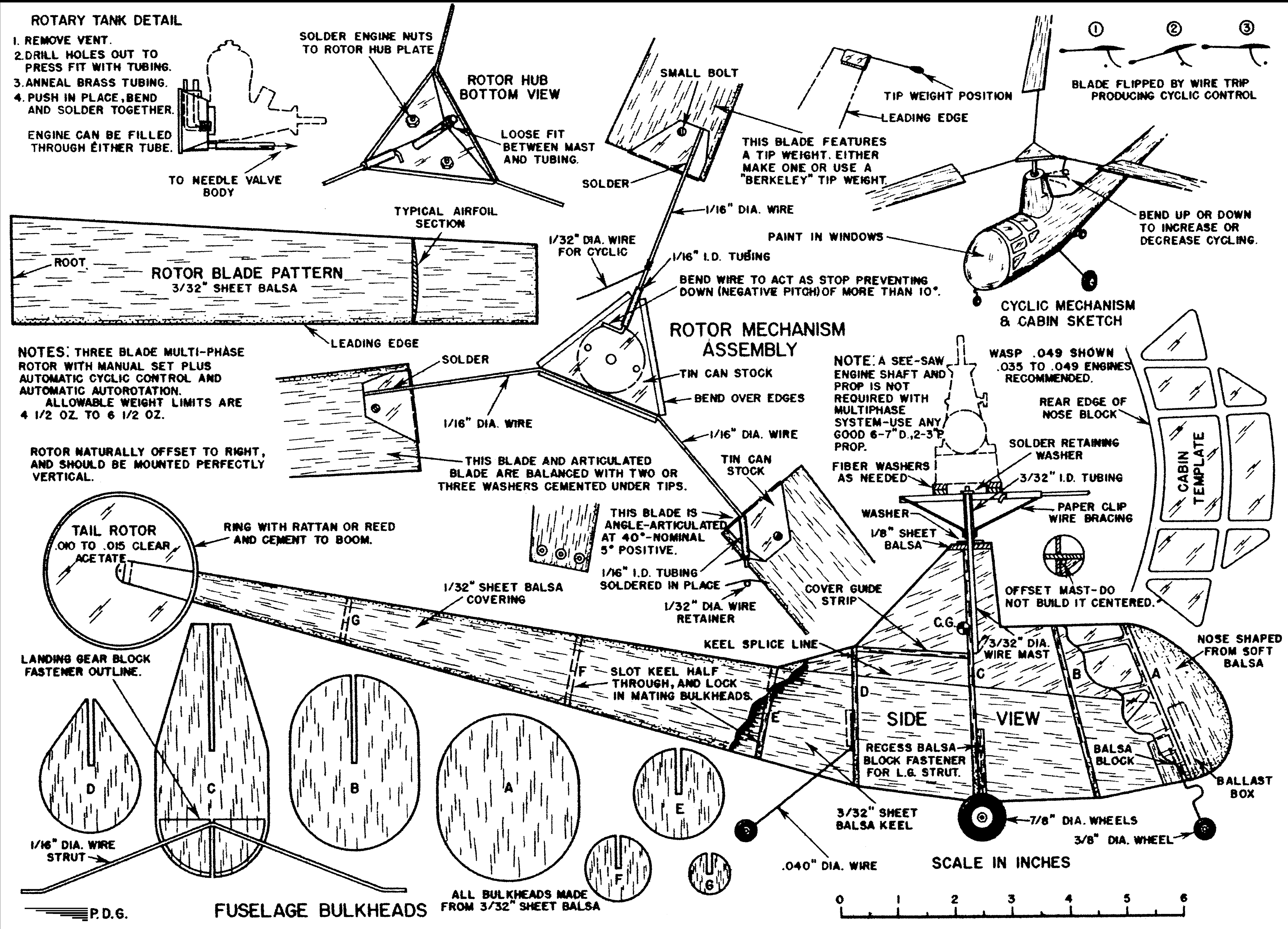
member helicopter model adjustments by making an analogy to fixed wing practice, thus:

Conventional Equivalent	*Helicopter*
Horizontal Stabilizer	Fixed pitch rotor blade or See-saw engine prop or Torsion tail surf ace (s)
Ailerons (wash-in—out)	Lateral mast tilt
Rudder	Tail rotor, mast brake, downwash fins under motor.
Thrust Line	Center of gravity location moving aft increases D.Th.
Glide Angle	Speed in Vertical FPM in Autorotation

Therefore we note that increasing the pitch of the fixed blade (s) reacts similarly to increasing the angle (negative) of a horizontal stabilizer, bringing the nose up under power, or, decreasing the gliding speed (rate of descent, power off). The rudder function, yaw, is obtained by a tail rotor, by a brake on the spinning main rotor, or by means of fins tending to promote or stop rotation of the fuselage in the slipstream. Aileron control, or bank-turn is by tilting the rotor laterally so the engine shaft inclines toward the desired direction, and altering the dynamic pressure on the feathering blades by moving the C.G. aft (or forward) resolves out as down-thrust or up-thrust respectively.



Full-size plans for the Sikorsky R-6 are part of Group Plan # 55A from Hobby Helpers, 770 Hunts Point Ave., New York 59, N. Y. (50¢)


ROTARY TANK DETAIL
1. REMOVE VENT.
2. DRILL HOLES OUT TO PRESS FIT WITH TUBING.
3. ANNEAL BRASS TUBING.
4. PUSH IN PLACE, BEND AND SOLDER TOGETHER.
ENGINE CAN BE FILLED THROUGH EITHER TUBE.
TO NEEDLE VALVE BODY
SOLDER ENGINE NUTS TO ROTOR HUB PLATE
ROTOR HUB BOTTOM VIEW
LOOSE FIT BETWEEN MAST AND TUBING.
SMALL BOLT
SOLDER
TIP WEIGHT POSITION
LEADING EDGE
THIS BLADE FEATURES A TIP WEIGHT. EITHER MAKE ONE OR USE A "BERKELEY" TIP WEIGHT.
① ② ③
BLADE FLIPPED BY WIRE TRIP PRODUCING CYCLIC CONTROL
BEND UP OR DOWN TO INCREASE OR DECREASE CYCLING.
PAINT IN WINDOWS
CYCLIC MECHANISM & CABIN SKETCH
1/16" DIA. WIRE
1/32" DIA. WIRE FOR CYCLIC
1/16" I.D. TUBING
BEND WIRE TO ACT AS STOP PREVENTING DOWN (NEGATIVE PITCH) OF MORE THAN 10°.
TYPICAL AIRFOIL SECTION
ROOT
ROTOR BLADE PATTERN
3/32" SHEET BALSA
LEADING EDGE
ROTOR MECHANISM ASSEMBLY
NOTES: THREE BLADE MULTI-PHASE ROTOR WITH MANUAL SET PLUS AUTOMATIC CYCLIC CONTROL AND AUTOMATIC AUTOROTATION.
ALLOWABLE WEIGHT LIMITS ARE 4 1/2 OZ. TO 6 1/2 OZ.
ROTOR NATURALLY OFFSET TO RIGHT, AND SHOULD BE MOUNTED PERFECTLY VERTICAL.
SOLDER
TIN CAN STOCK
BEND OVER EDGES
1/16" DIA. WIRE
1/16" DIA. WIRE
THIS BLADE AND ARTICULATED BLADE ARE BALANCED WITH TWO OR THREE WASHERS CEMENTED UNDER TIPS.
NOTE: A SEE-SAW ENGINE SHAFT AND PROP IS NOT REQUIRED WITH MULTIPHASE SYSTEM-USE ANY GOOD 6-7" D., 2-3" P. PROP.
WASP .049 SHOWN .035 TO .049 ENGINES RECOMMENDED.
REAR EDGE OF NOSE BLOCK
CABIN TEMPLATE
TIN CAN STOCK
FIBER WASHERS AS NEEDED
SOLDER RETAINING WASHER
3/32" I.D. TUBING
WASHER
PAPER CLIP WIRE BRACING
1/8" SHEET BALSA
THIS BLADE IS ANGLE-ARTICULATED AT 40°-NOMINAL 5° POSITIVE.
1/16" I.D. TUBING SOLDERED IN PLACE
1/32" DIA. WIRE RETAINER
COVER GUIDE STRIP
OFFSET MAST-DO NOT BUILD IT CENTERED.
TAIL ROTOR
.010 TO .015 CLEAR ACETATE
RING WITH RATTAN OR REED AND CEMENT TO BOOM.
1/32" SHEET BALSA COVERING
C.G.
3/32" DIA. WIRE MAST
NOSE SHAPED FROM SOFT BALSA
KEEL SPLICE LINE
SLOT KEEL HALF THROUGH, AND LOCK IN MATING BULKHEADS.
SIDE VIEW
RECESS BALSA BLOCK FASTENER FOR L.G. STRUT.
BALSA BLOCK
BALLAST BOX
3/32" SHEET BALSA KEEL
7/8" DIA. WHEELS
3/8" DIA. WHEEL
.040" DIA. WIRE
SCALE IN INCHES
0 1 2 3 4 5 6
LANDING GEAR BLOCK FASTENER OUTLINE.
1/16" DIA. WIRE STRUT
A B C D E F G
ALL BULKHEADS MADE FROM 3/32" SHEET BALSA
FUSELAGE BULKHEADS
P.D.G.