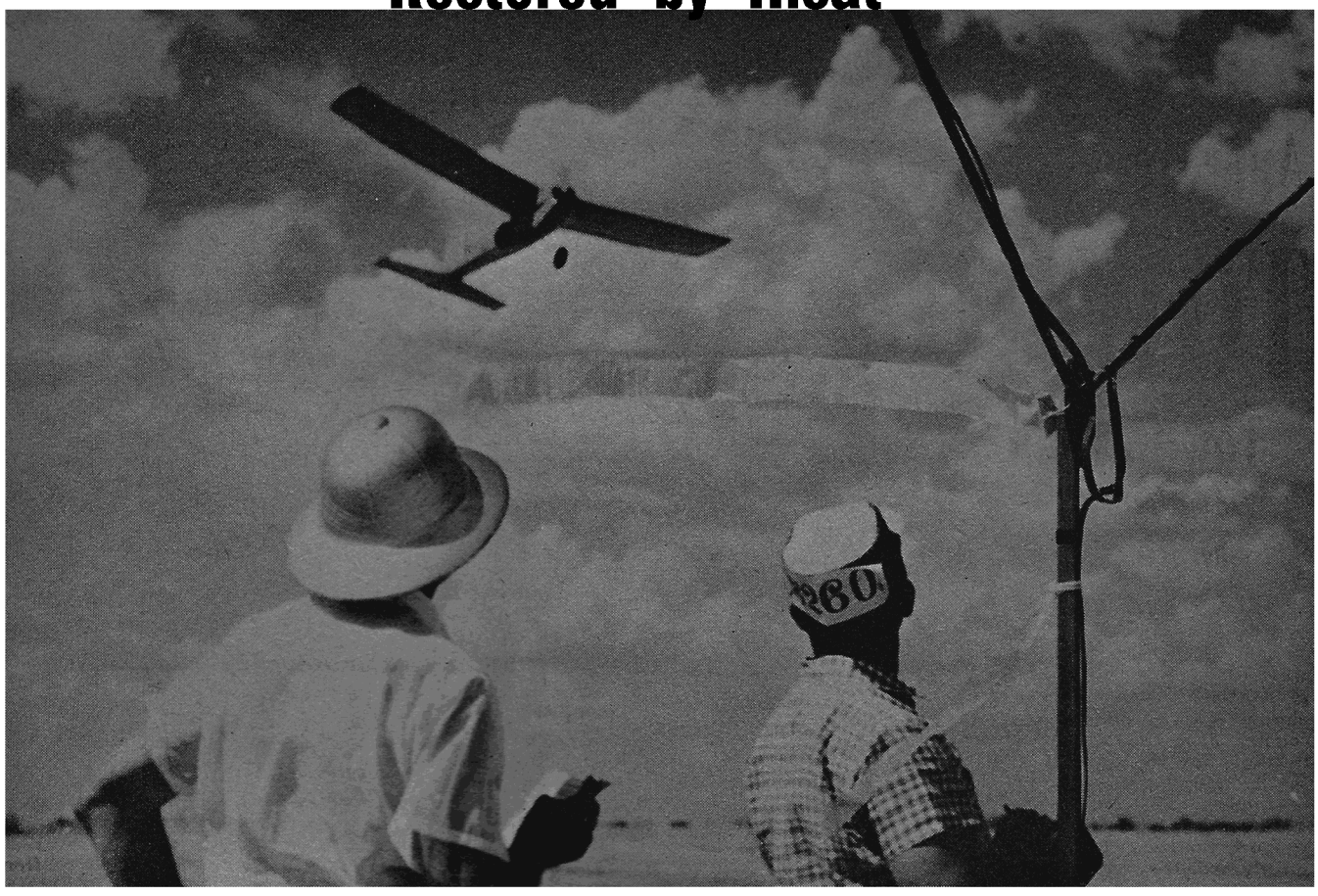

One of the best-known, thoroughly-proven R/C planes:

Walt Good's "Multibug"

■ The Multibug was designed especially for the dual proportional radio control system using the rudder and elevator. It is capable of a smooth precision pattern and also the full AMA stunt pattern. The original Multibug with over 100 hours of flying time, has placed in three National Meets and won first place at the Miami King Orange Meet in 1957. In addition to simultaneous proportional rudder and elevator, the plane features three-speed engine, steerable tail wheel and brake and a fail-safe system which neutralizes the controls on demand. A "snap-back" landing gear allows landings on all types of surfaces. Many Multibugs and modifications have been built by the DC/RC members with good success so the design is well shaken down.

Patterned after the old Rudderbug the Multibug displays many of the same stable and tolerant characteristics. A dual ship requires a good control at all elevator positions and flight speeds and must not be cantankerous near the stall. The Multibug seems to fill this bill. In fact the design is rather functional for this reason. As one "friend" said, "I don't like the looks of the plane but I sure like the way it flies."

A long tail moment and a 20% stab give stable longitudinal control. Smooth elevator control is obtained for normal flight, shallow "buzz jobs," straight down dives, inverted flight, and inside and outside loops.

For roll control the combination of the ample dihedral of 7° in each wing panel and a large movable rudder produce fairly rapid roll rates. Smooth precision turns as well as vertical pylon turns are easy and, with practice, slow rolls, which you'd swear used ailerons, are possible. The 7% fin and the body side area provide damping so that the turns are smooth without the jerkiness sometimes associated with the "dutch roll" effect.

The triangular cross-section of the body aft of the wing is believed to allow good airflow around the rudder under all flight conditions.

The early Multibug employed the NACA 4412 wing section which is 12% thick with a flat bottom and fairly high lift. This selection would allow all the stunt maneuvers except good outside loops. Even with plenty of down elevator the wing would stall inverted on the back side of the outside loop. Single outsides were possible if you had over 500 feet of altitude, held only enough down to keep the wing from stalling and kept your courage all the way through the "tuck under" part of the loop! The 4412 flew well inverted and was capable of very tight and safe maneuvers when right side up. Simply to do good outside loops the section was changed to a 1½ x 4412. This was Hank Bourgeois' idea to take the upper surface of the 4412, cut all vertical dimensions in half and add to the bottom to give a semi-symmetrical airfoil with a two to one ratio of the upper to lower surface. This amount of asymmetry gives very good outside loops. The plans show both airfoils. Section I is the NACA 4412 flat bottom and Section II is the 1½ x 4412 which is semi-symmetrical. For sport flying we recommend the flat-bottom Section I because of its high maneuverability. Section II is primarily for stunts involving outside loops.

The squared off trailing edges of the rudder and elevator always seem to bring on that look of "boy, is he lazy!" Of course that is partly true, but the real reason is that in proportional, the control surfaces should be effective right down to small angles. We visualize a turbulent "shadow" flowing behind the fixed rudder and stab. The control surfaces are immersed in the "shadow" and do not become effective until they push out into the fresh air. Thus, a pointed trailing edge would be a "dead" control until it had been moved through a large enough angle to emerge from the "shadow." We make the surfaces as hollow boxes so they are light and easy to build.

On the very first flight of the Multibug

Dr. Walter A. Good, former National R/C Champion, and president of Academy of Model Aeronautics, flys his Multibug (Norman Deitchman photo).

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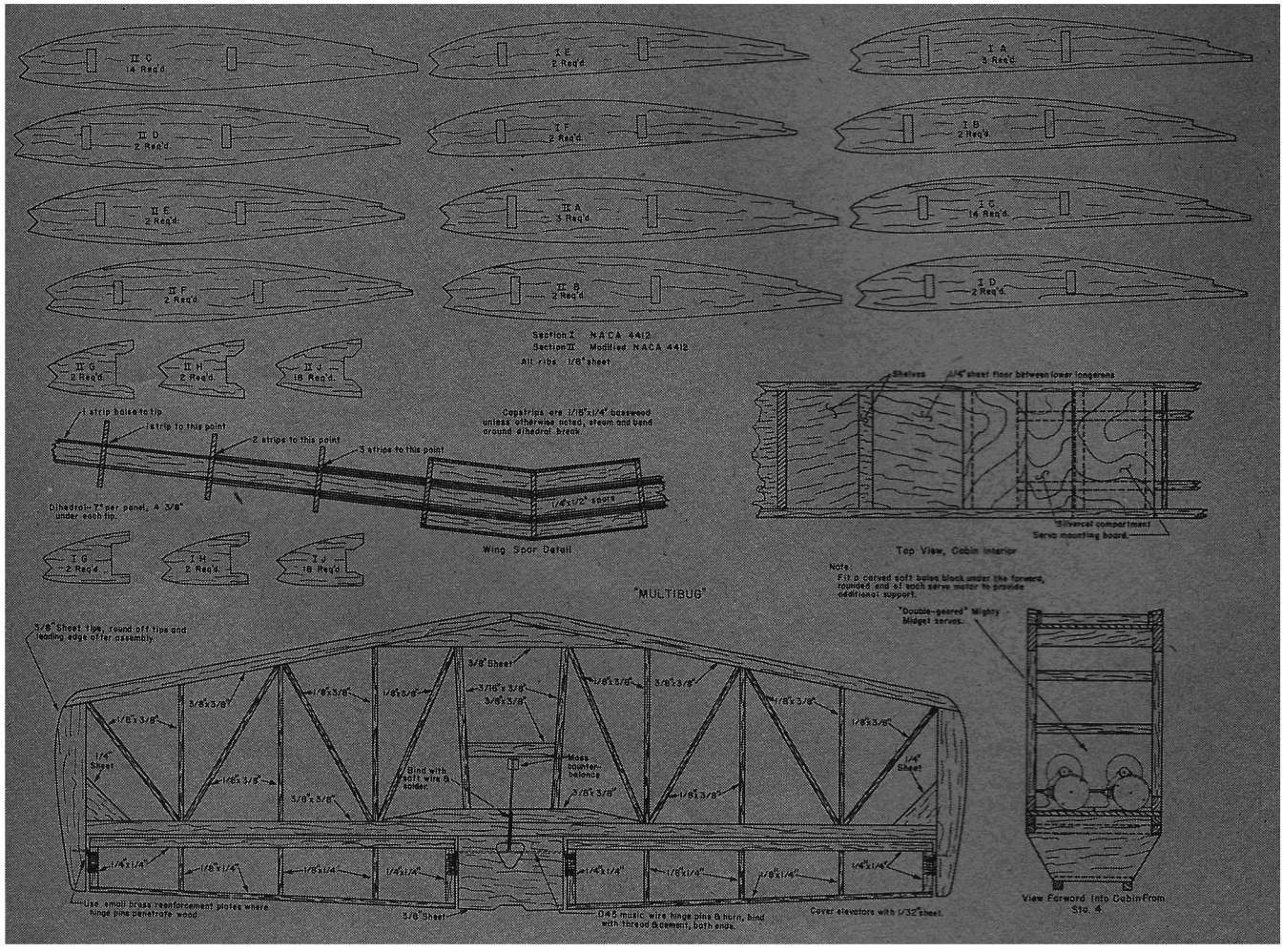
the pullout from a shallow dive was accompanied by a loud fluttering noise emanating from the plane. Keen eyed observers said the tips of the stab were just a blur several inches thick. Momentarily elevator control was weak but then the noise disappeared, the stab stopped vibrating and the plane landed safely only to be packed to the workshop for an important addition. A small brass weight was fastened to the end of the elevator control arm. The purpose was to balance out the mass of the elevator surface. This completely cured the flutter trouble. Flutter can be severe enough to crack the stab so be sure to add the balance weight right from the start. Note that the stab and fin are of flat construction 3/8" thick. This makes the



building easier and the resulting surface is flatter. Keep the fin and stab as light as possible by selecting medium balsa and by using only a few coats of dope.

The wing structure is of the flexible type which relies on the nylon covering for its final strength. This technique has worked well in practice even though you may see the wing tips flex several inches during a full elevator pullout. The spars are assembled at the dihedral joint and the basswood spar caps are added before wing assembly. The caps add strength in a progressive manner with the greatest strength in the center. The ribs are slipped on and the wing is assembled on a dihedral board. The wing tips are washed out by means of the taper in the trailing edge. This is important because it allows the plane to be flown at slow speeds with full-up elevator without unexpectedly dropping a wing tip. At the same time it does not prevent inverted flying from being accomplished.

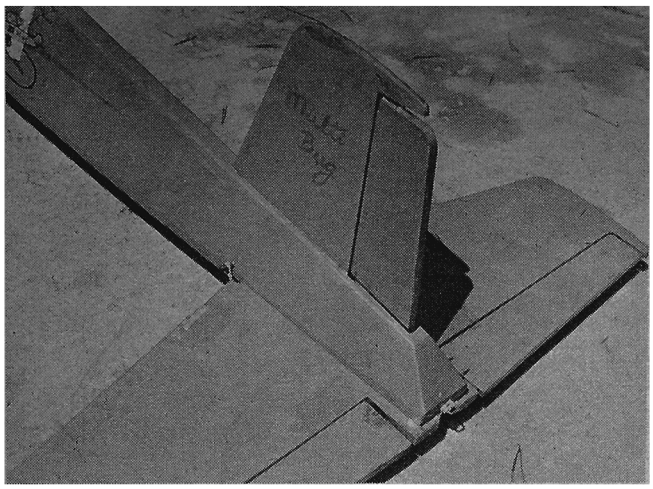
A .35 engine pulls the ship well. All-up weight of the ship is about six pounds. For really peppy performance try to keep it below six. With a Bramco type engine control 3 speeds have been found quite adequate. An old Good Bros. 4-spoke escapement was brought into service by bending one spoke out of the way. The result was an unambiguous sequence of Lo—Hi—Med. Under noisy contest conditions, you can blip through the sequence and latch on to the desired speed without hearing the engine. We often use the medium speed for the precision pattern and spiral dives. Lo engine for power dives and landings. Hi engine for climb and stunts. Propellers in the range from 11/5, 11/6 and 12/4 seem to match the engine and plane the best. If the engine bleats and complains in a dive the pitch is too low. If the engine slows and groans in a steep climb the pitch is too high.

The 4 oz. tank gives about 11 minutes on a Fox 35 but some of the hungrier engines such as the Veco may require a 6 oz. tank to get the 10 minutes for contest flying. The side mounted engine has worked well and makes the needle valve very accessible. Zero down thrust and 3 degrees of right thrust are built into the firewall.

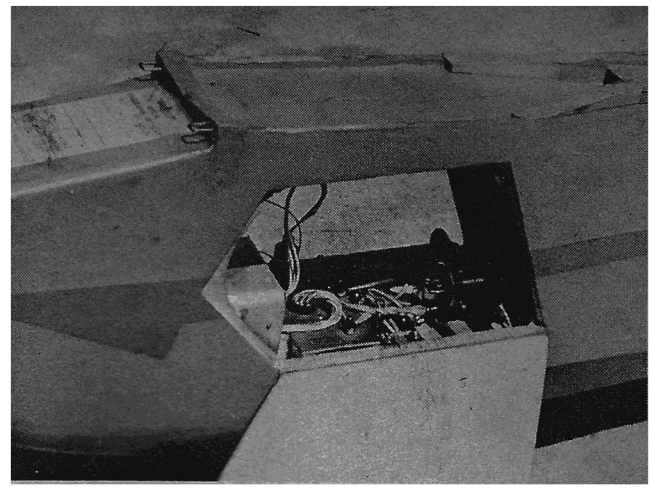
The landing gear was designed especially for our DC/RC farm field which is usually covered with a clover landing "arresting system." This gear snaps back without being pulled off by the clover. On hard surfaces, the gear is quite adequate if the internal spring or rubber is strong enough. You should be able to pull back on the axle with three to four pounds before the spring starts to give.

The radio installation is the WAG-TTPW dual proportional. The receiver is in a metal can and has several strips of 1/4" foam rubber cemented to it before slipping it into the receiver compartment. The five LR-1 Silvercels drop into the compartment just behind the gear. Four cells are for the servos and the fifth is for the filament. Because of the high voltage (1.5 to 1.7V) of a Silvercel, a one-ohm resistor should be added in series with the wire to the filament battery. For the 45V B battery we use two stacks from the K-45 size which normally has three stacks giving 67 1/2 V. Thus, two K-45's will make three flight batteries. Greater life will be obtained if three half-pen cells are added to the two stacks. Such a battery will settle down at about 44 volts for many weeks. Most of the B battery weight can be eliminated by using the little one-half ounce DC to DC converters which are now available. The converter would pull about 60 ma from the 6V servo battery. The TTPW receiver averages about 4 ma and hits 10 to 12 ma on fail-safe so get a converter that will handle this load at 45 volts.

The servos are "double geared" Mighty Midget motors with 3V from each battery leg. We find the brushes will take



There's a good reason for the squared-off trailing edges on rudder and stab. They give smooth control through zero angle and "shadow area." See text for explanation.



View into cabin shows edge of receiver box on left and servo motors on right. Note centering band in front of motor. Design is result of extensive testing over long period.

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about 20 hours of flying before requiring cleaning. When deeply grooved the brushes should be replaced. Bearings from brass tubing (3/32" O.D., 1/16" I.D.) for all shafts greatly improve the motor life. The drawings show balsa torque rods of ⅜" square. Some fitting and carving may be required to take care of mechanical interference between the rod and fuselage. We coat the rod with Ambroid to stiffen it and reduce some of the wind up. We still use a #32 centering rubber on each motor shaft. The rubber band should be quite slack so it does not cause end loading on the motor shaft at the center position. Return to exact center is not essential for adequate fail-safe operation. It is best to start flying with two bands on each motor to provide limited control deflection and then return to one band after a dozen or so practice flights. For full stunt capability the rudder can go plus or minus 30 and the elevator plus or minus 25°. On the ground the surfaces should hit these limits with the stick in the ½ to ¾ position. In flight the air load will just allow full deflection of the surface for full stick deflection.

The CG should lie between 30% and 40% of the wing chord. This is from 3½" to 4¾" behind the leading edge. It is safest to start at 3½" although it may not spin at that CG. Later move the CG aft for more active elevator action and easier spins.

At the field make a 200 yd. distance check to obtain accurate tuning on the receiver. Also check for proper operation with the engine running at all three speeds. For the first few flights, ask an experienced dual proportional pilot to take the stick. *This is important.* He can quickly compensate for out of trim effects and will also know when to kick the engine into low speed and head for the ground if trouble develops. It is nice to have straight flight with a slight climb with neutral stick; the rudder and elevator can be shifted by re-centering the rubber bands on the servo motors. When the ship is up several hundred feet and flying away from the pilot then the owner can take over and try his hand. Try easy turns at first and ease in a little up elevator to keep the nose up. At first, it is not unusual for a new pilot to get his ups and downs and rights and lefts mixed up, so keep the instructor nearby. It may be helpful to keep yourself lined up with the plane by flying over your shoulder but eventually you should keep thinking of the plane as if you were in it and the left-right confusion will go away.

If it's a little windy just push in a little down elevator and snort along. Pretty soon you'll find it takes a very strong wind to keep you and your dual proportional ship on the ground. In the DC/RC we now find ourselves flying steadily on windy days which would have kept the plane in the car a few years ago.

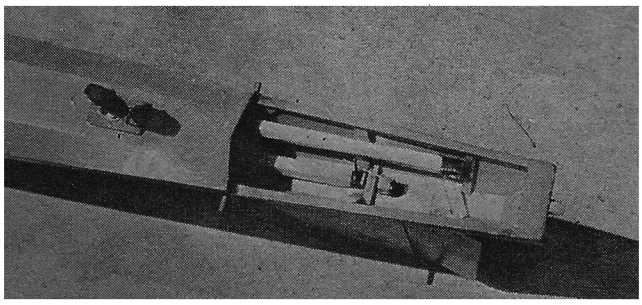
When the engine cuts and you start to glide into a landing, hand the box back to the instructor! Your first elevator landings are liable to be rather erratic. The aim is to hold the nose down a bit to maintain good speed for rapid control, then as you near the ground slowly ease back on the stick to slow the plane. Now use the last bit of up as you flare and touch down to a nice slow three point. You will find one time she'll come in too hot and coast all the way across the field and the next you'll slow down and stall out a hundred feet short. Don't be discouraged if your first twenty landings are worse than your rudder-only experience. With a little practice you'll soon have the flare and the touchdown both at the intended spot. And there's no thrill like perfectly flared no-bounce landing.

For more violent flying, remove the extra centering bands or put on a weaker band. If a slow gallop develops in which you can't hold the ship smoothly level, then the centering is too weak or the linkages are binding.

Several modifications of the Multibug have been made by the DC/RCers. Some prefer a wider fuselage so an added ½" is quite tolerable and gives more equipment space. A longer and wider landing gear stabilizes better for windy weather runway work but this usually requires a forward brace wire to assist the return spring. Lower dihedral has been tried but the rolling characteristics get much weaker below 6° per panel.

A very promising advancement has been pioneered by Maynard Hill and Jim Martin. They have added proportional ailerons simply by wiring the aileron motor to the rudder motor. Thus, the rudder and ailerons move together and provide an extremely rapid roll rate. And furthermore, this requires no additional radio gear. In this case they have

Underside shot of fuselage shows linkage and tail wheel. Full size plans for Multibug are on Group Plan #159 from Hobby Helpers, 770 Hunts Point Ave., NYC (59)—$1.25.



Multibug stabilizer showing elevator and counter-weight on arm to prevent flutter described by author. Read complete article for interesting tips on "dual proportional."

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(*Continued from page 28*)

dropped the dihedral to 3° or 4°. And spins are still possible. More experimenting is needed along this interesting approach to standardize on the proper proportion of the movements of the coupled ailerons and rudder.

We are sure you will be pleased with your very smooth proportional flying. More how-to-fly tips will appear in another article.

WEIGHTS:—Wing 19oz.; Stab 3 oz.; Body 42 oz. Total radio gear:—24 oz. Total:—88 oz.

Reference to: WAG-TTPW Dual Proportional Radio Equipment; AM—Jan.; Feb., Mar. '57. (These issues no longer available from the publisher.)

(FLASH! Flying his Multibug Dr. Good wins LARKS' Pylon event with 36.3 mph.)