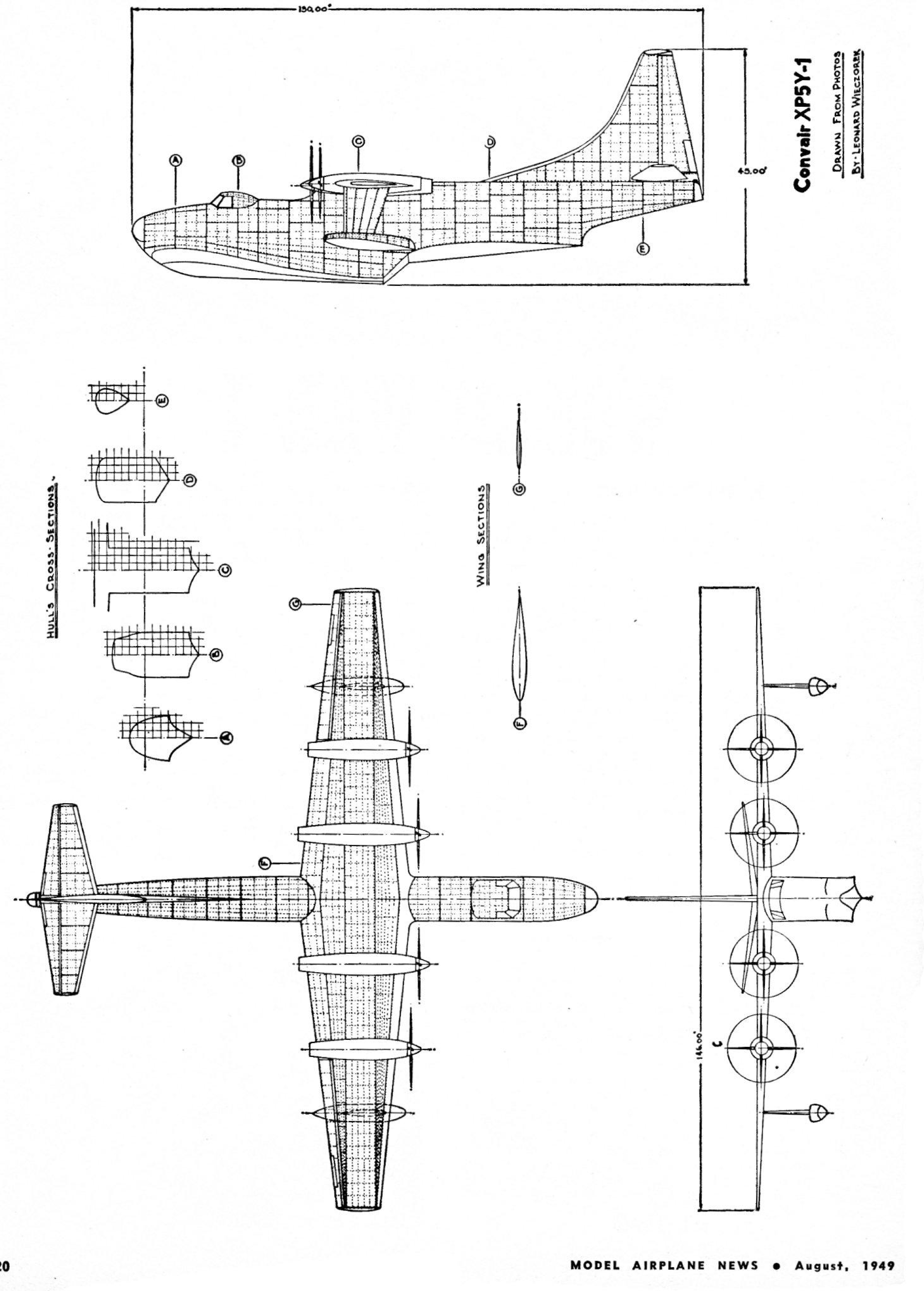
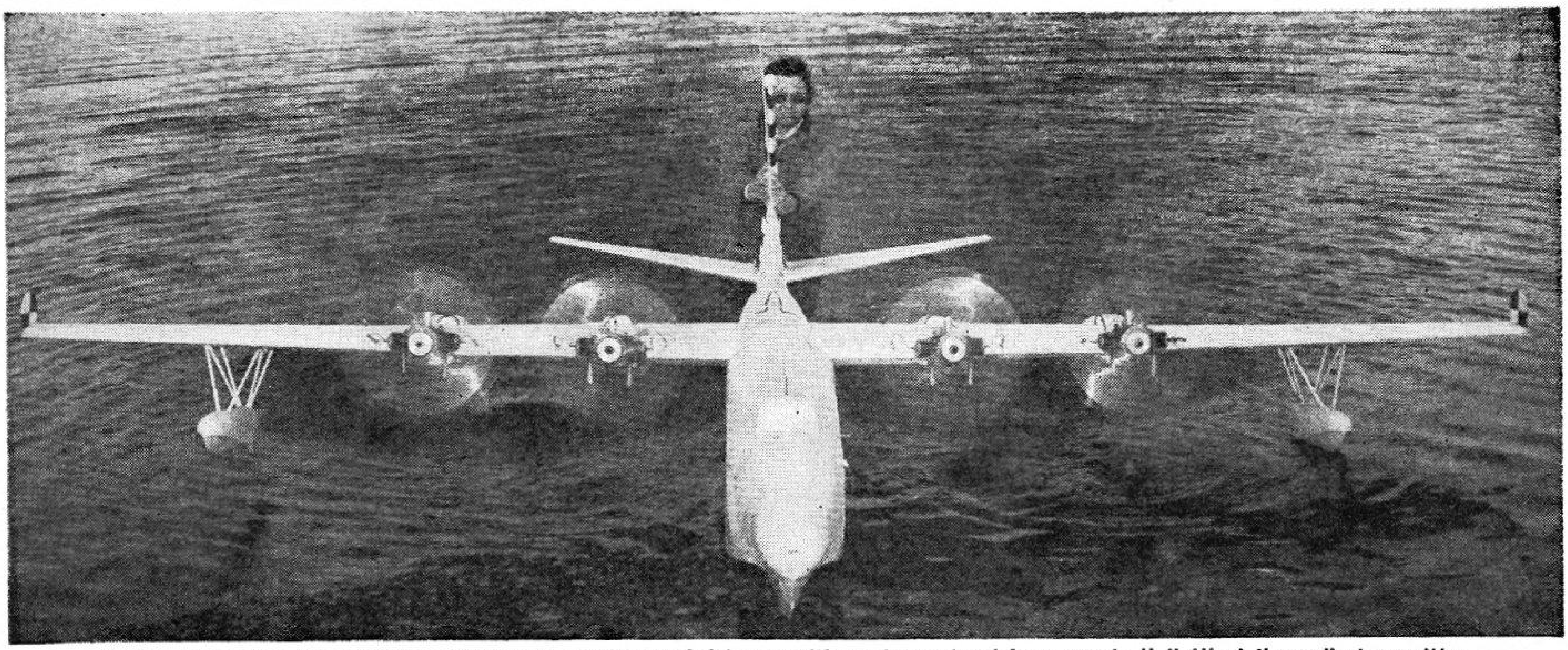
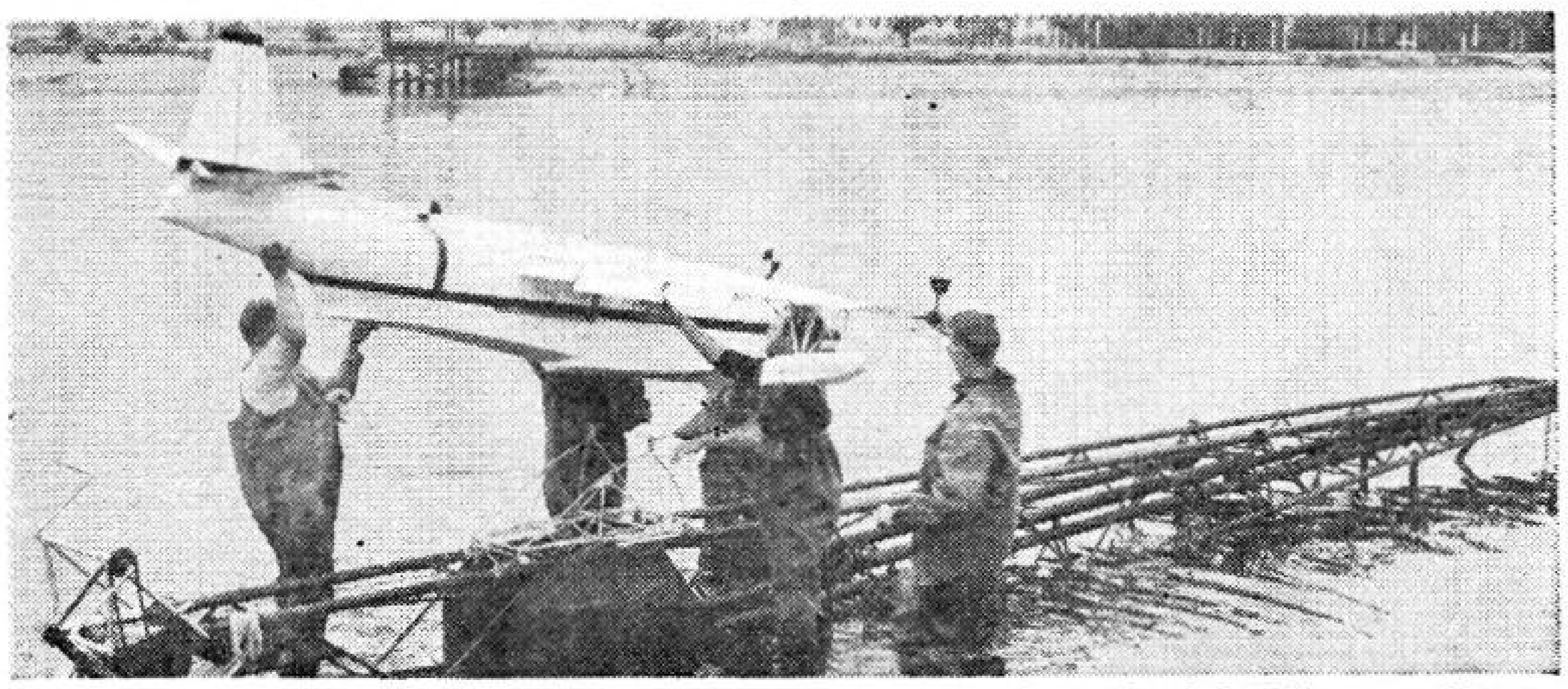

Convair XP5Y-1
Drawn From Photos
By Leonard Wieczorek
130.00'
45.00'
Hull's Cross-Sections
Wing Sections
146.00'

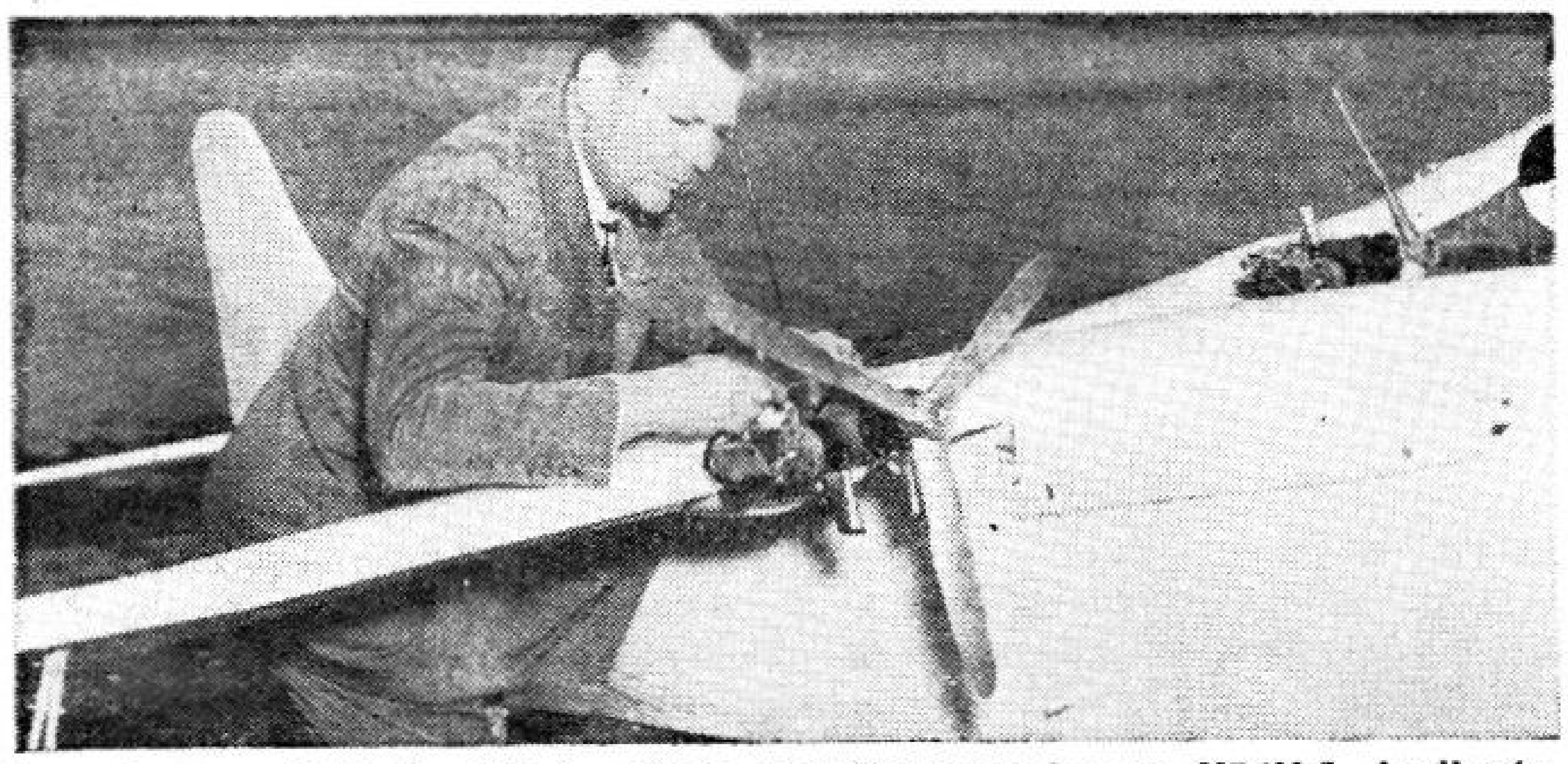


Motors screaming, the XPY5-1 model is held back by technician awaiting release signal from remote "pilot" at the radio transmitter

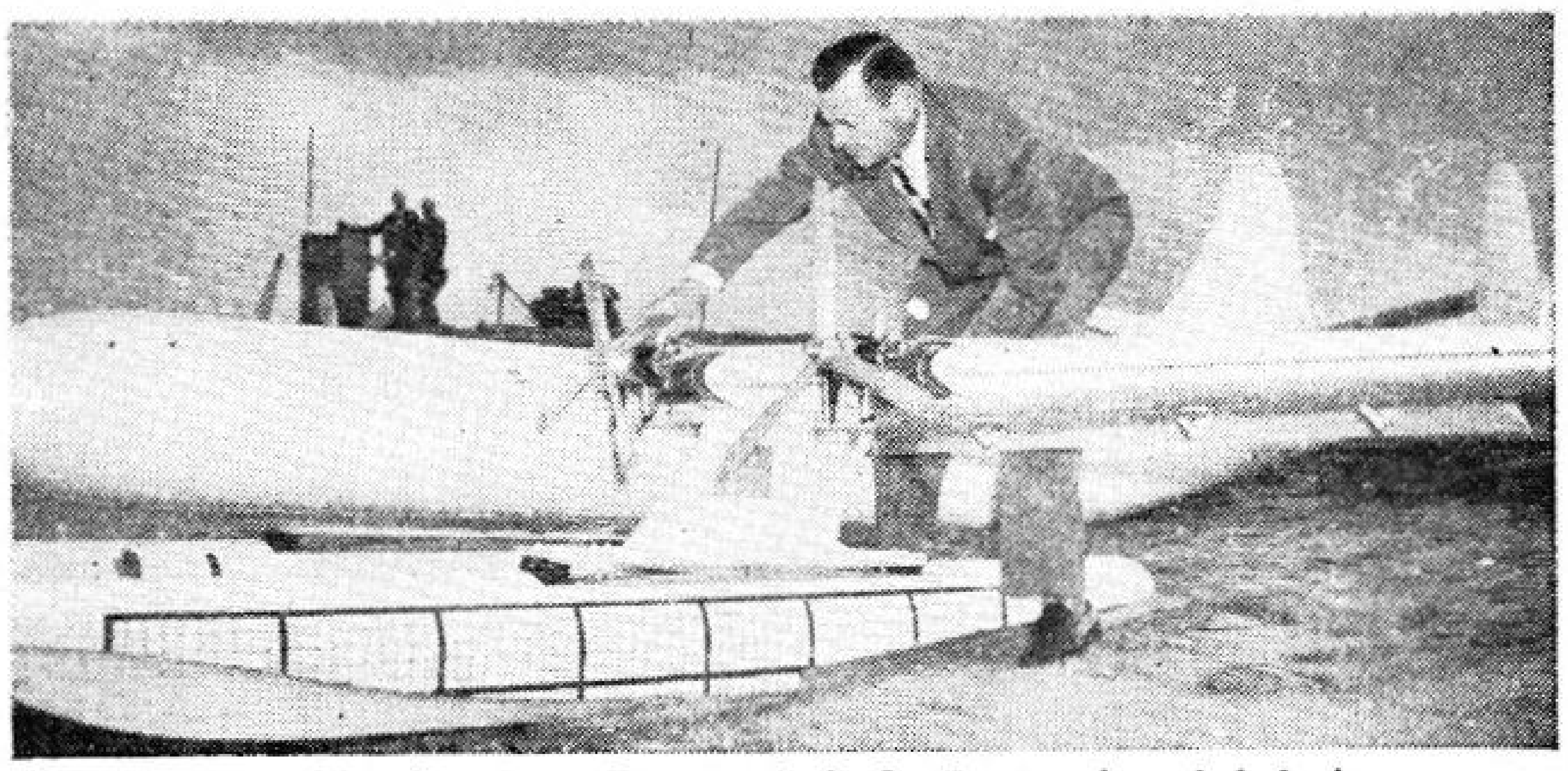
Radio Control "DELUXE"



An unpowered R.C. job is prepared for catapult launch to check landing reactions



Convair expert E. G. Stout adjusts 2-cylinder motor on XP4Y-1 duplicate



Here Mr. Stout works on a twin-float experimental design

by ROBERT McLARREN

THE day of the dare-devil test pilot has passed. No longer does a leather-garbed adventurer climb aboard a rakish new aircraft and take his life in his hands as he races down the runway on the first flight of an experimental airplane. By the time a modern prototype taxis to the take-off point, its designers already know almost all there is to know about the new craft, and the first test flight is actually an anticlimax!

While this procedure may dull the enthusiasm of the layman, the saving in time, money and risk is a remarkable tribute to scientists and engineers of the modern aircraft industry who have reduced yesterday's guesses to today's known facts. The purpose of all aircraft research is to reduce aerodynamic phenomena to accurate formuli and design charts that can be used safely *in advance* of the construction and flight of a projected airplane. The past 30 years have witnessed an astonishing improvement in design methods through the use of which the exact performance and characteristics of an airplane may be known in advance.

One of the earliest of these methods was the use of the wind tunnel in which a scale model of the projected airplane is placed and its lift, drag and pitching moment obtained. Another early method, still in widespread use, is the testing of full scale assemblies of the airplane in a structural testing laboratory to determine the exact load the structure will carry before failure.

During the late 'thirties the spin-tunnel was created into which scale models can be tossed and the spinning characteristics, together with recovery methods determined. For flying boat models, the towing basin has proved highly accurate in determining the hydrodynamic characteristics of the airplane. But throughout these years of research, during which a huge mass of testing techniques and methods of evaluation have been developed, no method had been developed for testing the effects of power on the model, and these effects can be large and serious when not known with sufficient accuracy in advance.

And so it was not until World War II that accurate methods of dynamic testing of aircraft models were evolved. In this method, small engines are actually mounted in the model and it is flown under its own power so that the full-scale aircraft is duplicated in every detail.

With the addition of thrust and the ability of the model to move in three dimensions, numerous problems are created which have not yet been completely solved, but remarkable progress has been made.

One of the first problems in dynamic model testing is the necessity for making the model "dynamically similar" to the full scale airplane; that is, the weight in the model must be distributed in a manner identical to that of the projected airplane. This problem is well known to model builders who have attempted to design exact-scale powered models of large aircraft by the simple expedient of using full scale aircraft draw-

(*Turn to page* 46)

Radio Control "DeLuxe"

(*Continued from page* 21)

ings for the model. The result is usually a first-flight failure. Extensive changes in the fore-and-aft location of the motor, size of tail surfaces, dihedral, etc., do not always produce a successful flying model and even those rare successes do not duplicate the full scale ship in take-off, flight and landing attitudes.

This difficulty arises from the fact that the weight of the model structure is not distributed throughout the airplane dimensions exactly as in the full-scale airplane. And so it was that one of the first problems in dynamic model testing by Consolidated Vultee Aircraft Corporation was the reproduction of the exact mass distribution of the aircraft design being examined. Even this widely-experienced organization was unable to duplicate this distribution accurately and after completion of the model found it necessary to distribute 22 lb. of lead ballast throughout the structure to reproduce the desired pitching moment of inertia of the projected airplane.

On its first attempt to conduct dynamic model testing, Convair was in the fortunate position of already having built and flown the full scale airplane, the Convair Model 31, Navy XP4Y-1. However, the model was designed and built to test several projected design changes, including the substitution of a single vertical tail surface for the twin tails used on the prototype.

The model was built of balsa with 1/8" plywood bulkheads and 1/10" planking. The exterior of the model was stripped with rice tissue paper laid in shellac, which sealed the porous balsa and provided a water tight structure for operation in water. The model was given three coats of spar varnish for extra protection.

The problem of "scale power" was a difficult one and Convair called on our old friends, Ohlsson and Rice, to produce a 1.5 hp, two-cylinder, two-cycle model engine. This engine is rated at 1.6 hp at 4250 rpm and weighs 3.5 pounds. It has a displacement of 2.77 cu. in. and a width of 9.5" over the spark plugs in the horizontally-opposed cylinders. Both cylinders fire simultaneously and a small direct-drive rotary impeller is fitted as a supercharger. The propellers were machined from 24ST and equipped for adjustable pitch.

Two of these engines were used in the XP4Y-1 model and four engines of a similar type but developing 2 hp each are mounted in the XP5Y-1 model. The latter drive four-blade, square-tipped propellers. Direct fuel injection is used and fuel is carried for about 30 min. flying.

With a dynamically similar powered scale model available for model test work the next problem is radio control and this is one of the most interesting features of the Convair program. Operation of the control surfaces on the model must also be as much to scale as practicable and thus it was impossible to use any two-position "bang-bang" type of radio control such as most of us are used to working with. First of all, Convair desired to control the ailerons, elevator, and rudder separately in order to duplicate the full scale aircraft. In addition, the flaps were controllable, the engines were throttled separately and the ignition system had a separate control. Thus, the XP4Y-1 had requirements for seven channels and the XYP5Y-1 nine channels. (This immediately takes these models out of the amateur class, at least as far as yours truly is concerned!)

In order to control the model realistically, the Convair transmitter is a full scale mockup of the pilot's compartment with seat, rudder pedals, control wheel, throttles, ignition switch and indicating instruments located on an instrument panel. This mockup is placed near the water's edge, the pilot takes his seat and the flight proceeds. Each of these controls is actually a variable resistor in an A.F. oscillator circuit. For example, as the wheel is pushed forward, the audio frequency of the elevator system is changed.

The transmitter is a four-stage, crystal-controlled unit with an output of 63 W. A single r-f carrier carries the seven audio frequencies. Navy security regulations do not permit mention of the carrier frequency but it is reasonably certain to be in the uhf region because of the released fact that the effective range of the transmitter is only 3500'. A major problem of such a system is created by the fact that since the positioning of any control is determined by the modulated amplitude of the corresponding audio frequency, an extremely sensitive automatic volume control system is an essential. In order to correct for the day-to-day drift in the synchronization of the equipment, trimming knobs are mounted on all channels to save the lengthy time required for trimming equipment not so equipped.

The receiver, mounted in the airplane, weighs only 12.5 lb. complete with waterproof dural case. The changes in modulation of the audio tone for any channel operates a relay. Actually, the relay equipment is two-stage, with the first stage a sensitive relay, operated as above, which, in turn, operates a power relay. Power is provided by B and C batteries plus two small 6-volt and two 2-volt storage batteries. These batteries are linked up into two 8-volt circuits, totaling 14 ampere-hour output. One of these circuits is for the engine ignition system, which is kept separate from the remainder of the control system.

The controls are operated by small Servo motors. Each Servo is a five-pole, split field electric motor driving a gear train which, upon rotating, pushes a gear rack out or in. Each of these Servos draws 1 A at 6 volts. Some indication of the power of these Servos is gained by the fact that they can exert 14 lb. before stalling! Each Servo is equipped with potential dividers that position the Servo in proportion to the modulated audio signal. This is, essentially, a potentiometer which balances the bridge circuit carrying the plate voltage. The Servo armature is equipped with magnetic braking, which minimizes overriding and hunting and provides a sensitivity of one part in 40, or less than 1° on most of the controls.

The special features contained in the Convair system are most easily described by outlining a typical test flight of the model. The model is started by a portable booster box containing batteries and leads connected to a switching panel. The model has a boost plug-in so that the model electrical system can be operated wholly from the ground supply. Each Servo actually has jack plugs so that it may be operated through leads from the ground booster box independently of the radio control system. The model is started by plugging in the booster to the throttle Servos. The throttles are manually controlled until the engine is adjusted for the flight and the warm-up period is completed. When the power lead is pulled, the batteries in the model are automatically connected. The model is then placed in the water, the radio switch is turned on, and the pilot at the mockup cockpit takes control of the model.

The model is then taxied out to the take-off position, its engines revved-up and it begins its take-off run. It climbs and maneuvers at the will of the pilot. When the 3500′ limit is exceeded, the maximum amplitude of the signal is gradually reduced with the aileron and rudder signals reducing last. As their signals are reduced, the model rolls over into a left turn and flies back into the range of the transmitter where full control is regained.

A small rate-sensitive gyro is mounted in the model to permit the pilot to make coordinated turns by the wheel alone. This gyro is engaged by a micro switch on the pilot's control wheels. While engaged, it will maintain the model at any stabilized attitude automatically since the rate gyro is sensitive only to the rate- of-change and not the change itself. This gyro controls the model's rudder and therefore the pilot's rudder is disengaged during the time the automatic pilot is operating. However, when it is desired to run high-speed water taxi tests, the pilot may control the rudder of the model by throwing a switch on his instrument panel.

During the flight, important test data are being recorded. The model carries an airspeed indicator, a clock with sweep second hand, a water speed indicator and a trim indicator grid. In addition, there is a transparent lens in the nose of the model. A motion picture camera is placed aft of this panel and facing forward so that a photographic record is made of the horizon as seen through the lens together with records of the instruments mentioned.

After landing the model is beached under its own power, making it possible for engineers to make a complete test flight without even getting their feet wet. The model is slowed down as it approaches the ramp by cutting some of the engines out altogether and intermittently cutting the ignition of the remainder. When a few feet from the ramp the ignition is cut altogether and the model floats up into its cradle. The film is then removed, developed and analyzed at the leisure of the engineers on the project.

The film method has shown shortcomings, however, and Convair has developed a much simpler method which uses a camera only on the beach. Broad black stripes are painted in the model and the camera follows the model in the water always keeping the horizon in the picture. By a system of descriptive geometry, engineers are then able to analyze the film and determine the angle of the model with the horizon regardless of whether it is coming towards or going away from the camera.

The principal interest of Convair in radio controlled dynamically similar models is in determining the take-off and landing characteristics of the seaplane on the water.

However, there remains little doubt that radio controlled landplanes could be used for the determination of handling characteristics, such as the stall, spin recovery, and dynamic stability as well as landing and take-off characteristics on runways.

Assuredly, like many other innovations in model building, radio controlled models have now graduated into the scientific field in the aircraft industry and modelers have made another contribution to aeronautical engineering.