

INSTRUCTION MANUAL FOR ASSEMBLY AFTER EXPORT

THE WACO MODEL F2

"NOT LIABLE FOR ACCURACY  
AND EFFECTIVENESS OF  
ORIGINAL TEXT."

The Waco Aircraft Company

## GENERAL INFORMATION

WACO airplanes are usually sold for Flyaway at our field in Troy, Ohio. The airplanes prepared for flyaway delivery are completed, carefully inspected, test flown, reinspected and held in our hangar until customer arrives for delivery. Please note that it is a policy of our company not to build surplus of airplanes for warehouse storage. Your WACO airplane will be strictly new when delivered to you.

WACOS for export shipment are set up, inspected, test flown, dismantled and carefully packed. The model "F2" is crated complete in a single crate for export shipment, the crate measuring 766 cubic ft. The net weight of the shipment being 1415 lbs., the gross weight 3420 lbs. and at 40 cubic ft. per measurement ton it figures 19.25 measurement tons.

### Transportation Liabilities

The WACO Aircraft Company does not hold itself liable for damage to airplanes or parts in transit from the factory. If a shipment is received in a damaged condition, have the delivery man or transportation company make a notation of the damage and file your claim with the carrier. In case of concealed damage, do not attempt to remove from shipping container or endeavor to repair, but call carrier and have claim agent inspect the damage before filing your claim with the carrier.

### Uncrating Export Box

The box should be placed at some point where a hoist will be available for lifting one end of the airplane.

First, remove the top of the box; then remove one side. Use care in doing this as there are fragile parts just inside the box which will be easily damaged if struck with tools while uncrating. Remove all the airplane parts from the open side of the box with the exception of the fuselage itself. Then from one end at a time remove all airplane parts down to the fuselage itself. Remove the ends of the box of course to do this. This will permit the removal of the remaining side and the remaining material.

### Assembly Instructions General

Rights and lefts are determined while standing at the tail,

and looking toward the nose of the airplane.

Bolts and clevis pins should be installed with heads up, forward or outboard. Make it a practice to tighten the nut and insert the cotter key on each bolt as used, never leaving any finishing process to be done at a later date. This will avoid the possibility of leaving out the very important cotter keys.

#### Landing Gear

The wheels should be assembled to the landing gear Vees held in place by collar and bolt shipped on axle. The cover plates on wheel should be removed in order to gain access to collar bolt on axle.

Now raise the motor end of the fuselage by attaching a hoist sling to the two lifting rings between cylinders #1 and 2 and #1 and 7, using a spreader bar between the two cables to prevent damaging cylinder head and parts about this region.

The landing gear Vees should now be attached to fuselage, inserting bolts using 2 - 3/8 X 2 5/8" in the upper end of shock strut; then the upper rear fittings using bolts 3/8" X 5 3/4".

Next spread the Vees apart and attach cross member to fuselage using 1/2" castle nuts on bolts protruding from under fuselage adjacent to shock strut attachment. Be sure to have clip used for attaching exhaust tail pipes under nut on right hand side. Then attach cross strut to Vees at lower end near leather boot using bolts 3/8 X 3 1/2.

#### Brake

Thread brake cable from bottom of fuselage, through landing gear Vee, entering tube at top of Vee fairing and coming out at pulley bracket attached to wheel brake flange.

To adjust operating system, jack up wheels so as to clear ground and move the brake operating lever by hand until wheel locks. Next pull cable at bottom of landing gear Vee tight and thread through the holes in brake operating lever as shown in Illustration #1. After this is done, operate rudder pedals back and forth several times so as to take up lay in system. It will now be noticed that the wheels will not lock as was the case before operating pedals. To obtain proper locking of wheel with respective rudder pedal depressed, the adjustment A Illustration #1 must be moved down thereby causing the desired action.

Note:

The above adjustment should only be made with the pedals in a neutral position and the hand brake operating lever full forward.

Brake Adjustment on Wheel

(Note) Export ships have been flown and had their brakes properly adjusted at the factory. They should, therefore, need little, if any, change when assembled.

If after several hours service, the brake lining should wear causing unsatisfactory results adjustment may be obtained as shown in Illustration #2.

Center Section

First, prepare the center section for installation by attaching the center section strut to the center section before installing it on the fuselage. The right hand strut can be distinguished as it has clips on both front and rear members for holding the gasoline lines, while the left hand strut has clips on the rear member only. The bolts,  $1/4"$  X  $1 1/4"$ , should be inserted with the nuts toward the center of the airplane and locked with cotter keys. (See Illustration No. 7).

Now with one man on either side of the center section, place this on the fuselage and attach the struts at the rear fitting on the fuselage first. After the rear fitting bolts are in place, the strut can be attached to the front fuselage fitting. The bolts which secure the center section strut to the fuselage are size  $5/16"$  X  $7/8"$ . The center section cross wires are  $5/16"$  streamline with one end left round for about half its length. Insert the round end of the wire down through the rubber grommet in the top of the cowling. Start the other end of the wire in the fitting, projecting from the under side of the center section. When threads are just started put the terminal on the lower end of the wire and give it the same number of turns that the upper end had in the center section, about two or three are sufficient. While holding the terminal at the lower end from turning, with a screw driver, tighten the wire until the terminal can be slipped over its fitting inside the cowling and secured with a  $3/8"$  clevis pin. The head of this pin should be toward the front.

Draw these wires up quite snugly, being careful that they are exactly the same length. They can be measured by inserting

a steel tape through the rubber grommet beside the wire or by the use of a trammel. The gasoline lines can now be fastened to the struts by the above mentioned clips and attached to the tanks by the fittings provided there.

It is important that the tubing be held firmly well up in the fitting while the fitting nut is tightened.

#### Tail Assembly

Before shipment the empennage is fitted on each airplane and is left as near assembled as is practical in shipment. You will, therefore, experience no difficulty in the reassembly.

Stabilizer and elevators will be shipped assembled and the first operation is to get the stabilizer right side up, which will place the ball nut on top. First, screw this ball nut on the threaded bolt which will be done by having one man in the cockpit work the stabilizer cord which will turn this bolt and let another man hold the stabilizer properly aligned so the threads will start. When the nut has been screwed down to a neutral position, attach the rear of the stabilizer to the fuselage with a 1/4 X 1 1/8" bolt.

The elevator control cables can now be connected making sure to attach to the top of the elevator horn that cable which comes from the bottom of the horn under the pilot's seat and to the bottom of the elevator horn that one which comes from the top of the forward horn. Adjust the elevator cables and the position of the elevators by means of turnbuckles just aft of the pilot's seat which may be reached through zippers in the bottom of the fuselage, being careful that not over two threads show from either end of the turnbuckle barrel after adjusting. When properly adjusted the leading edge of the elevator at the extreme point of the balance should have a down travel below the stabilizer when in full down position of approximately 10 1/4". (Note Illustration No. 5 for this measurement).

Hold fin approximately in position and attach navigation light wires taping them to one side so they will not conflict with any moving parts.

Install the fin by inserting the fin into the tail-post bolting it in place with a bolt just above the lower rudder hinge. The bolt is size 1/4" X 1 1/2". Fasten the front of the fin to the bracket on the stabilizer support tubes with a bolt 1/4" X 5/8".

Inspect carefully all nuts and cotter keys and then install tail cowl. First, screw front section of tail cowl in place, then hold the two sides which go at the rear of the tail cowl in place and hook the spring at the center. This will hold the two sides roughly in position while the wood screws are inserted along the bottom, one small machine screw inserted at each side in front fastening the upper parts of the side cowl to the front cowl and  $1/4"$  X  $1\ 5/8"$  bolt inserted to hold the two sides together at the rear.

Attach the top and bottom tail wires to the stabilizer using  $1/4"$  X  $1\ 3/4"$  bolts. The bottom wire is the shorter one. The clip on the stabilizer end of the top tail wire is more nearly straight than that on the upper end. Tighten the tail wires being careful that stabilizer is kept straight. When properly adjusted both bottom wires will be the same length and both top wires the same length. Check by eye to see that the fin post is perpendicular to the center section and the stabilizer is parallel to the center section.

The rudder may now be attached. When properly fitted the U bolts may be drawn up so as to hold the two halves of the aluminum bearings tightly against one another without binding.

Bolt the rudder wires to the rudder horn and if necessary adjust turnbuckles until rudder action from stop to stop gives comfortable pedal action.

#### Wing Rigging

Thread the navigation light wires from the upper wings down through the diagonal (center) interplane struts and bolt the struts to rear fitting on upper wing using  $1/4"$  X  $1\ 1/2"$  bolts. Also attach the front interplane struts to the front fittings on the upper wings. The lower ends of the front struts have adjustment screws which were properly set when the ship was flight tested. Do not change these settings until after flight testing. Bolt these lower ends to the diagonal struts using  $1/4"$  X  $3/4"$  bolts.

The wing wires consist of eight  $5/16"$  streamline wires. The two shortest are the landing wires. The four next longer are the double rear flying wires, and the two remaining, the longest, are the front flying wires.

With one man in the rear cockpit and at least two men handling the lower wing, attach each lower wing to the fuselage using  $3/8"$  X  $2\ 1/8"$  bolts. Bolt the front spar fitting to the fuselage fitting placing this bolt with head to the rear;

then using a  $3/8$ " X  $1\ 1/2$ " bolt secure the rear spar fitting to the fuselage placing this bolt head front.

Attach the rear landing wire to support the wings temporarily until ready to attach the upper wings. It is usual practice to attach streamline wires with the right hand thread at the lower end. It will be necessary to disconnect this landing wire while putting the upper wing in position.

After both lower wings are in place, the upper wings should be installed in the following manner:

(Note Illustration No. 6). After protecting the rear cockpit cowl have a man stand on this cowl and guide the upper wing into position. This man should have four  $5/16$ " X  $1\ 3/4$ " bolts threaded for  $3/4$ " together with four pair of taper bushings, one pair to go on each bolt. At least two men will be required to place this upper wing in position and a fourth man will be required to support the lower wing while the upper is being secured.

Loosen the landing wire supporting the lower wing temporarily and place the upper wing in position, being careful to see that landing wire terminals from the center section go down through the patches provided in the upper wing for these terminals. The man on the center section will then bolt the upper wing securely to the center section using bolts and bushings above described. The diagonal wing strut can then be attached to the lower wing and the landing wire again screwed in place. The wings on this side will now be self-supporting and the upper wing can be placed on the other side in the same manner.

The front landing wires should be tightened until they measure  $9\ 1/2$ " between pin centers.

Attach and tighten flying wires to hold wings in this position and then attach rear wing struts. If the rear landing and flying wires touch each other, they should be padded to prevent wear. Tighten all wires to a fair tension, making sure they are left in a streamling position.

With the control stick in neutral position adjust aileron control rods so that ailerons will be flush with the lower wings and connect these control rods to the aileron control horn, using  $1/4$ " X  $1$ " bolt. Attach the aileron struts with the adjustment end down using  $3/16$ " X  $3/4$ " bolts and adjusting them so that the trailing edge of the upper aileron will be parallel to the trailing edge of the upper wing.

Lubricate the various working parts of the control system. Use Engine Oil. Mobiloil Aero "H" summer and Mobiloil Aero "W" winter. Controls will naturally be rather stiff on a brand new airplane until they have been worked in somewhat.

Screw on the inspection plates furnished for the various inspection openings on the wings. Then close zippers in the fuselage cover which have been opened during assembly.

#### Gas Tank Fittings

Screw gas gauges in place in lower surface of center section. Screw vent lines in place in upper surface of center section taking care to have openings in gooseneck line towards the REAR. Don't use any Gas tite" solution on threads at this joint.!

#### Propeller

Make sure both propeller hub and propeller shaft are perfectly clean. Cover the propeller shaft with Mobil Oil Aero "H". Force the propeller on the shaft tight using the small nut which screws on the end of the shaft. Screw the lock nut on the propeller and lock it with the wire provided. (See Page 11 for further propeller instructions).

#### Final Check

Check all bolts, clevis pins and turnbuckles to see that they are properly locked with safety wire or cotter pins. See that lock nuts on all streamline wires are tight.

Fill the oil tank with an oil of the body character of Mobiloil Aero "H" for use during the warm months of the year and an oil of the body character of Mobiloil Aero "W" at atmospheric temperatures below 32 degrees F.

Grease rocker arm shafts with grease-gun filled with Mobil-grease, or a lubricant of similar character.

After filling oil and gas tanks, check all lines for leaks. See Motor Instruction Book for full particulars concerning motor operations.

The airplane is now ready for test flight after the brakes have been tested in taxiing. Taxi the airplane out and try first right brake and then left brake, taxiing enough to make sure the brakes are in correct adjustment and will operate either together or separately as applied.

If properly rigged, the airplane should fly in a normal course with "hands off" for an indefinite period in smooth air. However, if it should prove to be a little right wing heavy for instance, this can be corrected by lengthening slightly the right rear interplane strut, or if left wing heavy, the left rear strut.

If any trouble should be experienced in setting up a new airplane, get in touch immediately with the nearest WACO dealer or the factory giving full details and the Serial Number of your airplane.

#### Stabilizer Control

Model "F2" stabilizer is controlled by a screw operated by a steel cable which extends from the front of the stabilizer up the right side to the front of the airplane, thus giving stabilizer control in both front and rear cockpits.

In front the stabilizer cable passes over a pulley just behind the firewall at the extreme right. The pulley fitting has been threaded for a distance of approximately 4". Play can be taken out of the stabilizer cable by tightening this pulley fitting using nut and lock nut provided for this purpose located just ahead of the firewall and easily reached with right side motor cowl removed.

If play is noticed at the leading edge of the stabilizer, this can be eliminated by removing part of the shims from the ball socket connection of the stabilizer to the adjusting screw.

#### Oleo Shock Strut

These shock struts are so constructed that initial landing shock is absorbed by the oleo action before the piston reaches the shock spring at the top of the strut. Taxi shocks are absorbed by this coil spring in combination with the normal oleo action of the strut.

You will note there is practically no rebound after the initial impact with the ground in a landing, as this initial

impact is taken entirely by the oleo action of the strut.

Very little maintenance is required. It only being necessary to check the oil level occasionally, every 100 hours if the ship is in regular service.

We suggest that at the end of each 200 hours you dismantle this strut completely, cleaning each part with gasoline, inspecting and refilling with new oil.

#### Instructions for Filling Strut

1. Drain existing oil into quart measure by removal of upper pipe plug in head of strut and by opening or removing drain cock near axle.
2. Add enough oil to what has been drained to fill quart measure to one and one half pints.
3. Connect a small funnel to a 4 or 5 foot length of rubber hose, the lower end of which is connected to the drain cock and pour oil from quart measure into funnel holding the latter as high as possible to insure a sufficient head. Close drain cock and safety with copper wire and replace upper plug securely.
4. General Electric #6 Transformer oil must be used and it is essential that no more than a total of one and one-half pints be put in each strut. Failure to comply with these instructions will result in unsatisfactory operation.

#### Instructions for Disassembling and Assembling Shock Strut

1. Drain oil into container having approximately one quart capacity, by removing plug "A" at top of strut and by opening drain cock "N" on lower end of splined axle.
2. Remove brake cable from operating level at wheel.
3. Remove bolt "B" attaching strut to landing gear cross.
4. Loosen lock nut "C" and remove.
5. Remove the five bolts "E" at lower end of strut and slide splined axle flange from out of external tube, thereby permitting the removal of internal mechanism.

6. Remove lock wire from retainer bearing "G" and unscrew same using a Spanner wrench in hole provided for such. Care must be taken not to burr up edges of slots on retainer bearing as this would cause scoring the inside wall of outer tube.
7. Pull piston assembly "H" from spined axle.
8. To assemble, insert piston assembly into spined axle taking care to get leather plunger inserted evenly ~~all around~~.
9. Slide copper gasket "J" over packing gland "K" and then slide packing gland over piston assembly into end of splined axle.
10. Insert packing in new retainer bearing and screw same down tightly back on splined axle and safety with wire, threading wire between holes in retainer bearing and hole in brazed clip on splined axle.
11. Pull piston assembly as far out as it will come. Slide piston stop "L" and spring "M" over piston assembly and replace back in main outer tube.
12. Secure piston assembly in place by means of shear nut.'
13. Replace bolts at "E" and "B".
14. Back out pipe plug "A" in top of plunger and refill with oil as per instructions.
15. Replace plug taking care to get cotter pin hole lined up with hole in piston assembly. Then cotter shear nut in place.

#### Gasoline System

The WACO model "F2" carries its gasoline in two tanks in the center section. It is important that vent lines protruding from top of these tanks be kept open at all times. It is also important that gas tank caps fit snugly and do not leak. Occasionally the steel clip fittings which hold these tank caps in place will get pulled out of shape and not have the correct tension. This can be quickly remedied by putting them back in shape with a pair of pliers and if this fails to stop the leak, one or two new cork gaskets should be used on the caps.

You need not become alarmed if, after filling the tanks completely, one tank appears to drain faster than the other. This

is normal and there is not set rule as to which tank will drain the faster under certain conditions. On some airplanes one tank will one day and the other the next. However, as soon as one tank really gets low, the other will automatically come in as both tanks are connected at all times above the shut-off valve.

You will note the right tank has been provided with two outlet lines, one at the front and one at the rear. This is to take care of all conditions and make sure the carburetor gets gas both during a steep climb, and a steep descent.

Note that the gasoline gauges owing to their position are not accurate on the ground because with the tail down all the gasoline runs to the rear of the tank and the gauge may indicate full on the ground when there is less than a quarter of a tank. The gauges, however, are accurate during level flight.

If the tank appears to leak, first make sure that all fittings are tight before going to the trouble of removing the tank. Leaks are usually found to be around the gasoline gauges or one of the fittings and are easily repaired by tightening, or, if necessary, removing and adding filler, such as clear dope or white lead to the threads and replacing.

#### Care of Fire Extinguisher

Be sure that the extinguisher is kept full of liquid (up to the level of the filler plug hole) and once every thirty days the extinguisher should be removed from the bracket, the handle unlocked and given a couple of pumps, after which the handle should be properly locked. Then with a downward movement (as used in making the ink in a fountain pen flow) clean the fluid out of the discharge nozzle.

By following these suggestions and the information printed in the label on the extinguisher, you will have an extinguisher that will function properly at the time you need it, and further prolong the life of the extinguisher.

#### Propellers

The efficiency and performance of an airplane is vitally affected by the propeller used.

### Metal Propellers

A metal propeller for the Continental A-70-2, 165 horsepower motor in order to give satisfactory performance up to standard, should be of 8 ft. 6 in. diameter and so adjusted that the motor will turn between 1680 and 1720 at full throttle on the ground. To improve specific performance it may be desirable to change this adjustment slightly. An increase in the ground R.P.M. will give you better take-off and a decrease will give you more economical cruising. The above setting however is what we recommend.

### Wood Propellers

A wood propeller for the Continental A-70-2, 165 horsepower motor should be 8 ft. 4 in. in diameter and should turn 1725 -1800 on the ground at full throttle.

### Care of the Airplane

Your WACO airplane is a piece of fine machinery and is deserving of care and attention. When not in use it should be stored in a hangar as near dustproof and fireproof as is available. The finish of an airplane deteriorates much faster when left out in the weather than when properly sheltered.

It is desirable to keep the airplane clean both inside and outside at all times.

With this in mind we advise the use of a cockpit cover at all times when the airplane is not in use. Even in a hangar it is desirable to use a cockpit cover as it lends so much additional protection.

Avoid loose gravel and cinders. Inspect tips and leading edges. If damaged return prop to manufacturer for repairs and rebalancing.

Inspect fittings and tighten if necessary. Inspect lines to see that chafing is prevented.

See that gauge is tight. If gauge comes loose, when fuel level is low raise the tail high enough so gauge can be removed without gas leaking out. Clean threads carefully and apply clean dope. Allow this to set two minutes and apply second coat. Screw gauge in and tighten, using pliers or small Stillson wrench, gripping gauge at bottom where it will not collapse. If water has collected in gauge remove plug and drain.

Inspect stabilizer adjustment for play which can be taken up by removing desired amount of shims between bail retaining plates.

Inspect motor mount bolts and tighten if loose, taking care not to tighten so much that bolt heads will cut into rubber.

Remove wheel bearings, wash with gasoline and ~~replace with new grease.~~ Eliminate any end play, which may occur, by adding wheel washer under retaining collar.

Inflate 6.50 X 10 tires to 20 lbs. pressure.  
Inflate 10 X 3 tail wheel tire to 30 lbs. pressure.

#### Cleaning the Airplane

We advise the use of gasoline for cleaning the airplane finish only when it is absolutely necessary to remove grease spots.

The best method of cleaning the airplane is to use Warm water and a flake soap, like Lux, washing a spot of say three square feet at a time and rinsing immediately afterward. Begin at the upper surface of one of the top wings and wash that wing, both upper and lower surface, working in from the top and across to the other side. Then wash fuselage, tail surfaces and lower wings and last landing gear.

After completely washing and rinsing one surface, say one complete wing, if a chamois is available, go over the surface with the chamois which will add to the smoothness and luster of the finish.

While washing the airplane, one has a good opportunity to inspect the vent patches along the lower side of the trailing edge of wings, and tail surfaces. These patches should be kept open at all times and it is well to make sure these are open by sticking a small instrument, say a match stub or something of that nature, through the holes as you come to them while washing. Care should be taken to keep water off the motor and also out of the cockpit.

#### General procedure for starting the Motor

1. Check gasoline supply.

2. Check oil supply.

3. Be sure that gasoline shut-off valve on the firewall is turned on.

#### Heywood Starter

When a Heywood starter is used, please note that the airplane has been provided with a Lunkenheimer priming pump on the instrument board. When it is cold or after the airplane has been standing for a while and you wish to start, first pump several shots with the primer.

Note there is a small overflow tube and this primer should be pumped until gasoline drops from this tube. This will indicate that the priming chamber is full. Then see that all is clear and turn on your switch with throttle closed, mixture controls full rich and use the Heywood starter.

If the motor does not start, in the first two or three seconds of starter use, stop and allow it to stand about one minute and try the starter again without using the primer.

If the motor fails to start, make another attempt using the starter and at the same time pumping the throttle (open and close) while the starter is turning. If this fails, it is possible the motor has been loaded and the next trial should be made with the throttle held about half open. If this is unsuccessful, the motor can be backed up as below described to unload it. See motor instruction manual.

Please note in attempting to start the motor without the starter, the primer is of no value because the primer does not go direct to the motor, but rather goes to the starter. Therefore, it should be disregarded in attempting to start the motor without the starter and cranking instructions followed as given below.

#### Continental Motor

1. Pump throttle (open and close) about eight strokes so that gasoline flows from the carburetor. Then close throttle completely.

2. With switch off, spin the motor fast about four turns, the throttle still tightly closed. This gets a charge of gas into the cylinders.



# The WACO AIRCRAFT COMPANY



TROY, OHIO  
U. S. A.

January 7, 1938  
General Letter #561

## Subject - OIL IN OLEO SHOCK STRUTS

We are rather worried about the general lack of oil in shock absorber struts which we have examined recently. We believe you are not paying sufficient attention to the maintenance of the undercarriage. A shock absorber strut without oil is a strut which will put possibly ten or twenty load factors into the structure instead of the limiting six load factors which are the design requirements.

In other words when there is no oil only a portion of the load can be absorbed by the spring, which is capable of absorbing only a small percentage of the absorption capacity of the strut when properly filled with oil.

It is easy to check the oil in the oleo struts. Have them inspected at each motor check period and fill them to a height four inches from the top of the struts when the airplane is standing normally on level ground. The later models have a gauged rod attached to the bottom of the filler plug.

In filling the shock struts use General Electric #6 Transformer oil, electric refrigerator compressor lubricating oil, or Lockheed brake fluid. If neither of these is available, a half and half solution of castor oil and alcohol may be used. If the above oil isn't obtainable locally we can supply it promptly.

In the future any damage claims involving the undercarriage will first be investigated from the standpoint of proper oil being in the oleo shock struts, and if proper oil is not found no claims will be considered. This is important and we urge you to give it your careful attention.

THE WACO AIRCRAFT COMPANY  
D. C. Flower

DCF:BZ