MAINTENANCE & SERVICE MANUAL

FOR THE

BOEING MODEL 247 TRANSPORT AIRPLANE

BOEING

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BOEING AIRPLANE COMPANY
(A Division of the United Aircraft & Transport Corporation)
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MAINTENANCE AND SERVICE MANUAL

Boeing Model 247

FOREWORD

The contents of this manual are offered to assist in the proper operation, maintenance, and inspection of Boeing Model 247 transport airplanes. The manual is prepared in loose leaf form so that additional changes, revisions, and/or additional data may be inserted without difficulty.

Since it is probable that these airplanes will be operated for the most part over established airways, and maintained by personnel experienced in the up-keep and maintenance of aircraft, we have refrained from going into lengthy details covering service methods, shop practices, and inspection procedures. The development of these airplanes was based, for the most part, on service reports submitted and experiences gained by operators of Boeing-built airplanes.

The purpose of the manual is to acquaint operations, repair and overhaul personnel with the general construction features and details of the Model 247. Many features of this airplane are relatively new to the industry and a brief descriptive resume of them will materially assist those charged with their successful operation. The useful life and reliability of any piece of mechanical apparatus depends upon the care it receives in order that it may function properly. This is especially true of aircraft and accessories of new design.

It is the aim and desire of the Boeing Airplane Company to deliver to its customers airplanes of proven airworthiness, designed and built to exacting specifications, properly tested and adjusted to give the utmost in safe and satisfactory performance. To meet the increasing demands placed upon the airplane as a means of transportation, close liaison between the operator and manufacturer is absolutely essential. In only this manner is the designer and manufacturer able to appreciate the service and maintenance problems encountered. To this end, we have employed for the past several years an "Unsatisfactory Performance Summary Chart", described herein, Section XIV. The data submitted by operators on these charts in the past has been of material assistance. Your cooperation in this regard is earnestly requested. In addition to the diagrams, and drawings forming a part of this manual, references are made to engineering documents and assembly drawings. Prints of these for use at Operations Headquarters and Overhaul and repair Depots will be furnished on request.

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SECTION I

GENERAL INFORMATION

1. Specification.- The following data are listed for the information of those concerned:

Designation	Boeing Model 247
Approved Type Certificate	No. 500
Seating Capacity	Crew 3; Passengers 10
Overall Span	74' 0"
" Length	51' 5"
" Height (incl.radio mast)	16' 0" (maximum)
Wing Loading (full load)	15.1 lbs./sq.ft.
Power Loading (full load)	11.5 lbs./H.P.
Total Wing Area (incl. ailerons)	836 sq.ft.
Wing Chord at Root	15'
Wing Section	Boeing 106 tapered
Incidence	3.5°
Sweepback - Front spar perpendicular to centerline of fuselage	
Ailerons - Chord	18"
" - Area, incl. balance	60.8 sq.ft.
Horizontal Stabilizer Area	73.8 sq.ft.
" " Span	25.5'
Vertical Stabilizer Area	17.6 sq.ft.
Elevators - Area	58.9 sq.ft.
Rudder - Area	27.9 sq.ft.
Longitudinal Trim Adjustment	Trailing flap on elevator
Directional Trim Adjustment	" " " rudder
Lateral Trim Adjustment	" " " left aileron
Landing Gear Tread	17' 6"
Cabin Dimensions	Approx. 6' high; 5' wide; 18' long
Cargo Compartments	Approx. 60 cu.ft. each
Fuel Capacity - Left Main	136 gallons
" " - Right Main	66.7 "
" " - Auxiliary	70 "
Oil	10 gallons each engine
Fuel Consumption - Approx. full power	50 gal./hr. per engine
Fuel Consumption - Approx. 3/4 power	35 gal./hr. per engine

SECTION II

POWER PLANT

1. Description.- The "power plant" consists of a Right and Left nacelle, including all equipment installed therein. In addition to the dynamotor-generator, the following associated electrical system units are installed only in the Left nacelle: one CB-68 plug-in type generator control box; one M-2836 dynamotor change-over switch; and one M-2658 solenoid switch for battery operation of the dynamotor. Details of operation and installation of the electrical and heating system units are covered separately in Sections VII and XI. Other equipment units, common to both nacelles, viz. booster coils, booster switches, tachometer generators, etc., are covered in separate sections. The engines are designated as Pratt & Whitney S1D1 "Wasps", having a compression ratio of 6:1, and a blower gear ratio of 10:1. The power rating is 550 horsepower at 2150 RPM at sea level; 550 horsepower at 2200 RPM at 5000 feet altitude.

2. Special Engine Operating Instructions.- (a) Oil Temperature and Pressure: The oil temperature gages in these airplanes are connected to the oil lines feeding the pressure pumps. Therefore they will show oil inlet temperatures which under normal conditions, are from 10° to 20° F. lower than the outlet temperatures. It will probably be observed that with the cooler in the circuit the oil will take longer to come up to temperature than without it. Actually it will warm up just as quickly as in the earlier models of Wasps, but due to employing inlet thermometers, these engines will not show an increase in oil temperature until the main body of oil contained in the tanks is heated by the return oil. When acted upon by the oil flowing out of the engines as in earlier installation, the indicators will show immediate temperature increases with the result that an airplane may be taken off the ground with the oil out temperature at the required value but with the oil going into the engines at a dangerously low temperature. To safeguard against this condition, oil inlet thermometers are employed.

Experience has shown that these engines are more likely to give more trouble when running with relatively cold oil than when operating with what is now considered hot oil. When the oil is cold it does not flow readily. Consequently, some parts of the engine may not receive proper lubrication. Stuck and broken rings and scored pistons and cylinders are often traced to lack of lubrication resulting from low oil temperature. From what is known about this problem it appears that no damage results from high oil temperature until of course the oil thins out to the point of losing pressure and the consumption becomes excessively great. 167° F. oil inlet temperature, the limit given in the Operator's Hand Book, will normally safeguard against excessive loss of pressure and high oil consumption. Temperatures above 167° F. are not necessarily dangerous as long as the required oil pressure is indicated.

Above 1200 RPM, oil pressures of from 75 to 100 lb./sq.in. are desired, but 60 lb./sq.in. is permissible. When the pressure falls below 60 lb./sq.in., the cause should be determined and the trouble remedied.

The oil will warm up more rapidly on the ground, and, due to the higher rotating speeds and increased oil pressures, the engines will receive better lubrication without overload if they are run at or near 1000 RPM directly after starting. Before taking off, it is highly desirable to have the oil going into the engine at or above 100° F., although under cold weather conditions this may not always be possible.

(b) Manifold Pressure and Engine Speed: These engines are rated at 550 HP at 2200 RPM at 5000 feet, but if opened up in level flight at sea level will develop 650 HP. As this is more load than the engine parts will safely carry, it is necessary to provide some means for regulating the power output consistent with the rating. Within the working range, horsepower is very nearly proportional both to absolute manifold pressure and engine speed. Therefore by providing instruments for measuring these values and establishing maximum limits, both for cruising and take-off, it is a simple matter to safely control the output. These limits are:

	Take-off	Cruising
Manifold pressure(inches of mercury)	34	28
Engine speed (RPM)	2200	2000

NEITHER THE LIMITING ENGINE SPEEDS NOR MANIFOLD PRESSURE SHOULD BE EXCEEDED. At altitudes below 5000 feet manifold pressure will be the limiting factor, while at the higher altitudes engine speed will control.

In case of emergency, it is permissible to exceed these values but not without recording in the log book the maximum pressure and engine speed attained, together with a notation of why they were exceeded and for what length of time.

Each gage is provided with a telltale hand which for each trip will show the maximum pressure if at any time the allowable manifold pressure for take-off has been exceeded. So as to be readily seen, that part of the dial below 28 in.hg. is painted black, the sector is intended for cruising, the white sector for take-off, and the red sector for emergency.

NOTE - Gages conforming to the above description were available for installation in NC-13301 and NC-13302 only. Standard Pioneer manifold pressure gages were installed in NC-13303 and subsequent articles. As soon as available, the former will be used.

Throttle stops, although provided, are of secondary importance. If used, they will merely serve as an indication of where the throttles should be located to give the maximum allowable manifold pressure for take-off. If the pilots find that during take-off they can properly manipulate the throttles by glancing at the manifold pressure gage, the throttle stops need not be used at all.

(c) Carburetor Icing and Distribution: Once ice forms, the addition of heat very often fails to clear the carburetors in time to prevent a forced landing. It is considered better practice to avoid the formation of ice by applying heat to the entering air in such quantities as to keep the temperature of the mixture above the freezing point of the moisture contained in it. From what is known at the present time about this problem it appears that a temperature of 100° F. should care for this condition without causing a serious loss in power. A thermocouple is installed in the air duct below each carburetor and indicates the temperature of the entering air. These thermocouples are connected into the same switch and indicator which is used for cylinder temperatures. Due to the inaccuracies in the indicator at the lower end of the scale, a white line corresponding to 100° F. is painted on the dial. The letters "A" stamped on the dial to the right and left of the vertical centerline indicate the proper positions of the switch for connecting the temperature indicator to the carburetor air thermocouples. If, under extreme ice forming conditions, it is felt that more heat is desirable, it should be used without hesitation. Furthermore, if ice is encountered, the preheater valve should be opened wide and the mixture leaned out as much as is safely possible. Tests have shown definitely that, due to the increased temperature of the exhaust gas, the preheater is from 20° to 30° F. more effective with a lean than a rich mixture. Although not good for the engine, if ice can be dislodged from the carburetor by leaning the mixture to the point of backfiring through the induction system, this procedure is authorized.

Due to improvements in the design of the induction systems in these engines, hotspots are no longer considered necessary. However, there will be times when preheating the entering air will still further improve distribution and result in smoother and more economical operation.

(d) Fuel and Oil Consumption: Gasoline having a nominal anti-knock rating of 83 octane is specified for these engines. If unavoidable circumstances require the use of inferior fuel, extreme care should be used in the operation of the engines. The throttles should be opened as little as possible for take-off and the mixture should be leaned out only enough to obtain smooth running. Whenever fuel known to be of a poor grade is in use, the cylinder temperatures should be carefully watched.

Until better facilities for regulating the fuel consumption in flight are available, it will be necessary to continue the present practice of observing cylinder temperatures, engine speed, color of the exhaust, and general operation of the engine when adjusting the mixture. Since these engines deliver more power than the previous models of Wasps, more care must be exercised in regulating the quantity of fuel burned. For cruising operations, it is important not to lean out beyond the point where the engine speed begins to fall off. For take-off, it is better not to lean the mixture more than is required to obtain smooth operation.

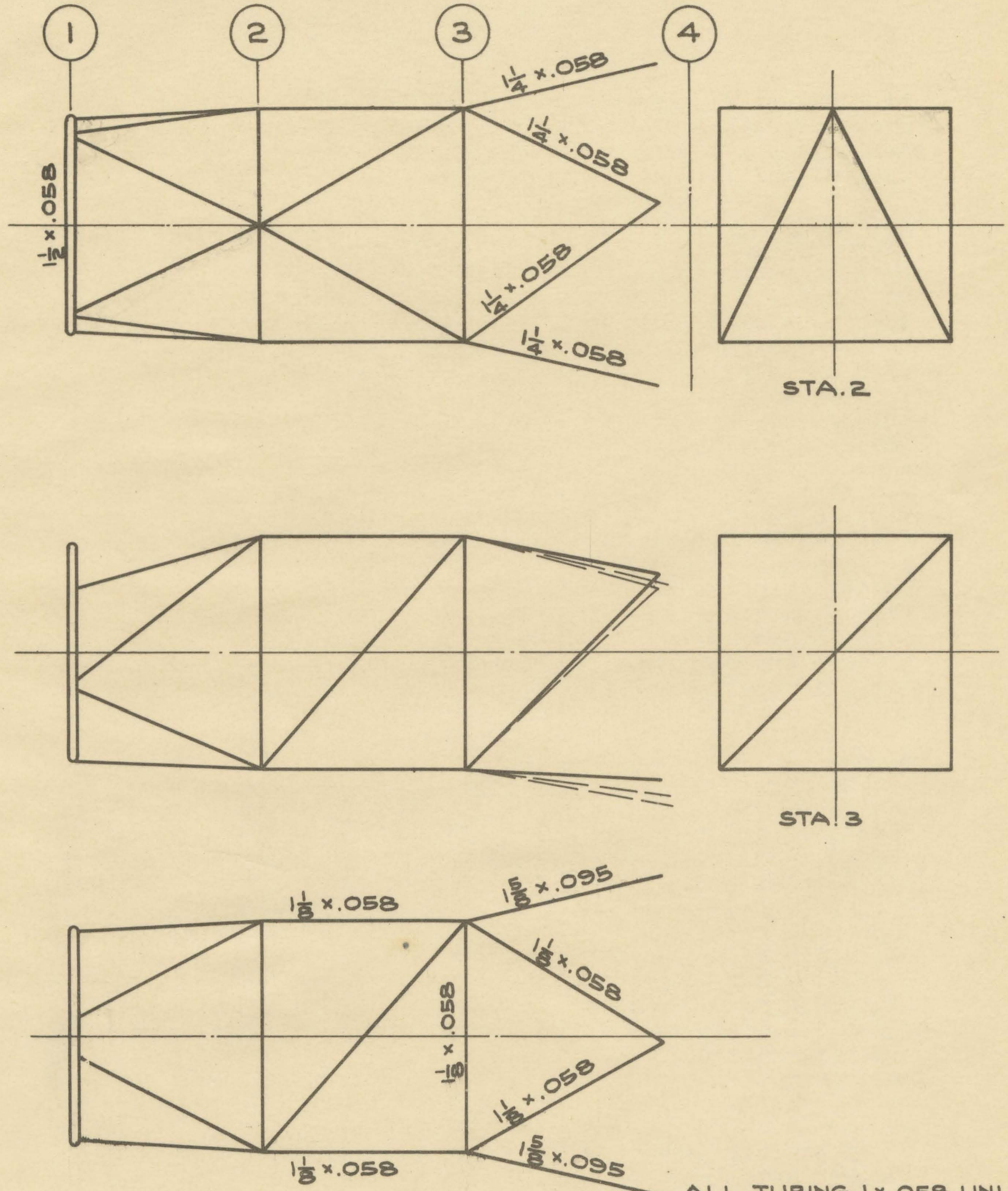
As soon as steadier and more sensitive tachometer equipment is available, the consumption can be regulated with ease and safety. The mixture will be leaned out until the tachometer shows a very slight reduction in RPM. If the engine loses more than 5 or 10 RPM, the mixture should be enriched just enough to regain the loss in speed. It should, however, be kept in mind that when reversing the motion of the mixture control lever, any lost motion in the connecting linkage will come into effect and make it necessary to move the control more than would otherwise be required.

It will be observed that the throttle and mixture control levers may be locked in position independently. This provision prevents the throttles from moving while the mixture controls are being adjusted. It will also be observed that the mixture control quadrants are graduated, a provision which, barring lost motion in the controls, will make it easily possible to return to the same mixture setting once the desired condumption for a given set of operating conditions has been obtained. Carburetor or engine changes or adjustments in the control linkage will of course change the relation of the control lever to the quadrant for a given mixture setting and make it necessary to redetermine the "best setting" position.

Attention is called to the fact that the amount of movement of the control lever with respect to the quadrant is no measure of the mixture strength and should not be used as a guide in regulating the fuel consumption. Usually the mixture control lever must be moved a considerable amount from the full rich position before it becomes effective. The amount of travel varies with different carburetors and linkages. Once the control is in the effective range, very small changes of position will as a rule effect the fuel consumption considerably.

3. Nacelles.- These structures are essentially the same--Rights and Lefts--except for the cowl and exhaust supports. When it becomes necessary to repair or splice a nacelle member steel chart, Figure 1 should be referred to. The nacelles are manufactured on steel jigs, and all joints welded by the electric-arc process. Extreme care must be exercised when installing a nacelle to the attachment fittings on the front spar. The nacelles are secured to the spars by means of four taper bolts in shear at each nacelle longeron and three bolts in tension at intermediate points. It is absolutely essential, to avoid twisting the front spar, to first install and tighten the four taper bolts, then properly shim the two abuttment fittings prior to tightening the nuts of the tension bolts. If and when it becomes necessary to install oversize bolts the tolerances shown on Fig. 12, Section III should not be exceeded.

4. Cowling.- To facilitate servicing and inspection of equipment in the nacelles, all cowling is designed for easy removal. Boeing "T" type spring fasteners are employed to secure the quickly removable sections and insofar as possible, self-locking nut clips and machine screws to secure the cowl supports to the structure. Hinged inspection doors are provided for access to the oil system drain cocks, filler necks, and generator control box. To facilitate removal of a nacelle from the wing as a unit, connector panels and junction boxes are provided on the front spar for all electric wiring and the thermocouple leads. Special connectors and turnbuckles are provided to break fuel lines, oil pressure lines, vacuum lines and control cables in the aft end of each nacelle. This feature will minimize previous difficulties encountered from wiring and tubing dangling about the structure during removal of a nacelle. It also provides for easy replacement of lengths of cable and piping in the engine section, especially those subject to deterioration from heat, oil, water, or vibration. All engine section cowling, as well as the exterior surface of the entire airplane, is finished by the anodizing process. This treatment is an electro chemical process which



ALL TUBING 1 × .058 UNLESS OTHERWISE NOTED.
ALL TUBING S.A.E. X4130 STEEL.

FIG. 1 - NAÇELLE STEEL CHART

causes oxidation of the surface of the metal. This oxide is an excellent repellant to corrosion. For this reason, extreme care should be used when handling or cleaning the cowl pieces or airplane to insure against scratching or breaking the surface.

5. Carburetor Induction System- This system for each engine consists essentially of the following component parts: a 6" diameter aluminum tube projecting upward and through inboard side of nacelle cowling, the upper end of which is covered with a wire screen. The lower end is connected to the top of an air mixing valve, Dwg. No. 14-833, located in bottom of nacelle below the oil tank. An elliptical shaped scoop is installed between the forward outlet of valve and carburetor. Anti-squeak material is employed to prevent undue wear from vibration. The scoop is secured in place by means of clamps incorporating spring-loaded bolts to permit slight weaving. To a third connection on the outboard side of valve is attached a short tube, the other end of which is attached to the hot air collector assembly around the exhaust tail stack. A fourth connection on the bottom of the valve projects through the bottom cowling to permit escape of the hot air when not being supplied to carburetor. A butterfly type vane in the valve assembly, actuated by a cable control from the pilot's cockpit, is used to obtain the desired amount of hot and/or cold air to the carburetor.

6. Exhaust System.- The exhaust collector ring and tail stack assemblies are of Boeing design, manufactured by the Solar Aircraft Company, San Diego, California. They are fabricated from .031, KA-2 stainless steel per Dwg. No. 15-2565 for the right, and 15-2566 for the left engine. These drawings should be referred to for manufacturing details. Each ring is made in nine sections--one for each cylinder. Each of these sections telescope into the adjacent section except those for cylinders Nos. 4, 5, and 6 on the right, and Nos. 6 and 7 on the left engine. These sections telescope into a "Y" fitting, the rear end of which enters a 5" diameter tail stack. A section of each tail stack is provided with seven longitudinal tubes. This tubular section passes through an enclosed area forming the hot air collector for the carburetor mixing valve.

The individual sections of the rings, instead of being bolted directly to exhaust ports per past practise, are clamped to short nipples installed on each port. This obviates the necessity for removing the ring assemblies during engine change. The rings proper are supported by the nacelle cowl structure. Two copper asbestos lined clamps are placed around the ring sections to support the right and left half of each assembly. These clamps in turn are secured to brackets on the cowl formers by means of drilled fillister head screws. Nut plates for the screws are provided on the brackets. During removal of a ring assembly it is necessary first to remove the fillister head screws and rotate the clamps slightly to slip the sections off the nipples.

7. Starters.- One each Eclipse Series VII hand inertia starter is installed on the right and left engine. No electric motors are installed on the starters; however, provision for installation of motors, conductors, and switches has been made, if in the future it is desired to provide battery operation. Each starter is provided with a 3/4" drive shaft extending through outboard side of nacelle cowling. A special crank with universal joint at driving end is furnished with each airplane. It is stowed in the front cargo compartment. This special crank with universal joint at driving end is furnished with each airplane. It is stowed in the front cargo compartment. This special crank permits winding up the starter by hand from the ground. A "T" handle for manual engagement of starter is provided on outboard side of each nacelle above exhaust tail stack. An Eclipse starter switch is installed on the starter engaging lever and a 1/16" cable is employed between this switch and "T" handle. This provides simultaneous operation of booster coil and engaging lever. To obtain clearance between starter cranking shaft and magneto shielding, it is necessary to install starters with shafts inclined upward approximately 15 degrees. It is also necessary to install the left starter with engaging lever on bottom; this to permit shaft to extend through outboard cowling.

8. Ignition System.- This system consists of two each Scintilla AG-9 magnetos mounted on each engine. The magneto distributor blocks and all high tension leads are completely shielded by means of Boeing Air Transport design ignition shielding. This shielding was installed on the S1D1 engines by the Pratt & Whitney Company during final assembly of the engines.

One each Eclipse C-19543 booster coil is installed in each nacelle adjacent to the right magneto. A short length of shielded high tension cable is run from HV connection of coil to HV connection of the right magneto. The current supply to the primary winding of the coil passes through an Eclipse B-22913 switch, installed on the engaging control lever of the starter. The current supply to the switch passes through the master ignition switch in pilot's cabin. This arrangement prevents the possibility of inadvertently energizing the booster coil if and when the master ignition switch is in the "OFF" position. Note Dwg. No. 14-800 herein, Section VII, for wiring installation details.

9. Fire Extinguisher System.- Located on the right side of the pilot's instrument board is a selector valve and "T" handle assembly for controlling the fire extinguisher system. The system consists of the above control unit, a 5-lb. bottle of carbon dioxide, located in the rear of the nose mail pit, and interconnecting piping. The installation is commonly known as the Lux system, manufactured by Walter Kidde and Company, New York, N. Y. Instructions for the operation and maintenance of the Lux system are supplied in a small envelope inserted in a slot provided in the release valve mounted on the top of the cylinder. To operate the system it is only necessary to set the selector valve handle for the desired nacelle and pull the "T" handle. Once the handle is pulled the entire contents of the bottle are expelled. No attempt should be made to stop the flow of gas by means of the selector valve. A 1/16" flexible cable is employed between the "T" handle and release valve on top of the CO_2 bottle. Short lengths of Titeflex tubing are employed between the control valve and interconnecting piping to absorb instrument board vibration. 7/16" O.D. dural tubing and plain Parker type dural connectors and Tees are used between the valve, bottle and nacelles. Fire extinguisher system piping is designated by BLUE bands painted around the tubing at convenient intervals. The tubing entering each nacelle is connected to a Tee from which one length of 7/16" tubing is installed in a semi-circle around the engine mount ring and a second section around the carburetor float chamber. Small holes drilled in these two lengths cause the CO_2 gas to be sprayed around the rear of the engine and over the carburetor. From a second Tee used in the supply line a short length of tubing is attached to a fitting on the side of the carburetor intake scoop. This directs some of the gas into the scoop. Access to the cylinder is had by removing a cover secured to the structure by means of machine screws and fiber nut clips. The bottle is attached to its mounting bracket by means of a bail type fastener. The cover should always be used over the bottle to protect it from cargo placed in the nose pit. When it becomes necessary to remove the cutter valve from a bottle, it should be borne in mind that the threads are LEFT HAND.

A small portable hand-operated Lux extinguisher is installed in the front end of the passenger cabin. Instructions for operation are shown on a plate attached to the extinguisher.

SECTION III

FUSELAGE

1. Description.- The fuselage of the 247 is of the all-metal, semi-monocoque design. Four longerons are employed to which are secured the station bulkheads. Between longerons and bulkheads, the channel stiffeners form a complete frame for the support of the skin. The complete fuselage assembly is manufactured and jig assembled in three separate sections. These sections are described separately herein. The interior surface of the skin, and the formers, stiffeners and bulkheads are finished with a coat of aluminum lacquer, except in pilot's compartment. This compartment is finished with dull black Duco. The exterior surface of the fuselage covering has no protective coating other than anodic treatment. All joints and seams are sealed by means of Goodrich "Plasticon" applied when the body sections are riveted or screwed together. Fuselages are given a water spray or rain test when removed from the final assembly jig. This is to inspect for water leaks prior to installation of the cabin lining. "Plasticon" is a rubber compound, soluble in gasoline, kerosine, carbon tetrachloride, and similar fluids usually employed for cleaning. For this reason these liquids should not be used for cleaning the fuselages as they will eventually dissolve the "Plasticon" applied between the seams and joints. It is, however, resistant to water.

2. Repairs to Skin.- If, and when, it becomes necessary to repair a small hole or dent in the fuselage structure, the procedure outlined in Figure 2 should be closely followed. It is most important that extreme care be used to prevent weakening the skin. In case of major repair or rebuild of a damaged fuselage, it is suggested that complete new sections of skin and formers be installed. Each main repair base should have on hand prints of Dwgs. 15-2485, 15-2486, 15-2487, for this purpose.

3. Oversize Bolt Tolerances.- For the purpose of interchangeability, allowance is made for reaming certain fittings throughout the airplane for larger size bolts than those originally installed. The locations and allowances are shown on Figure 12.

4. Installation of Tubular Rivets.- At certain points in the structure, viz. mail pit lining, weather stripping

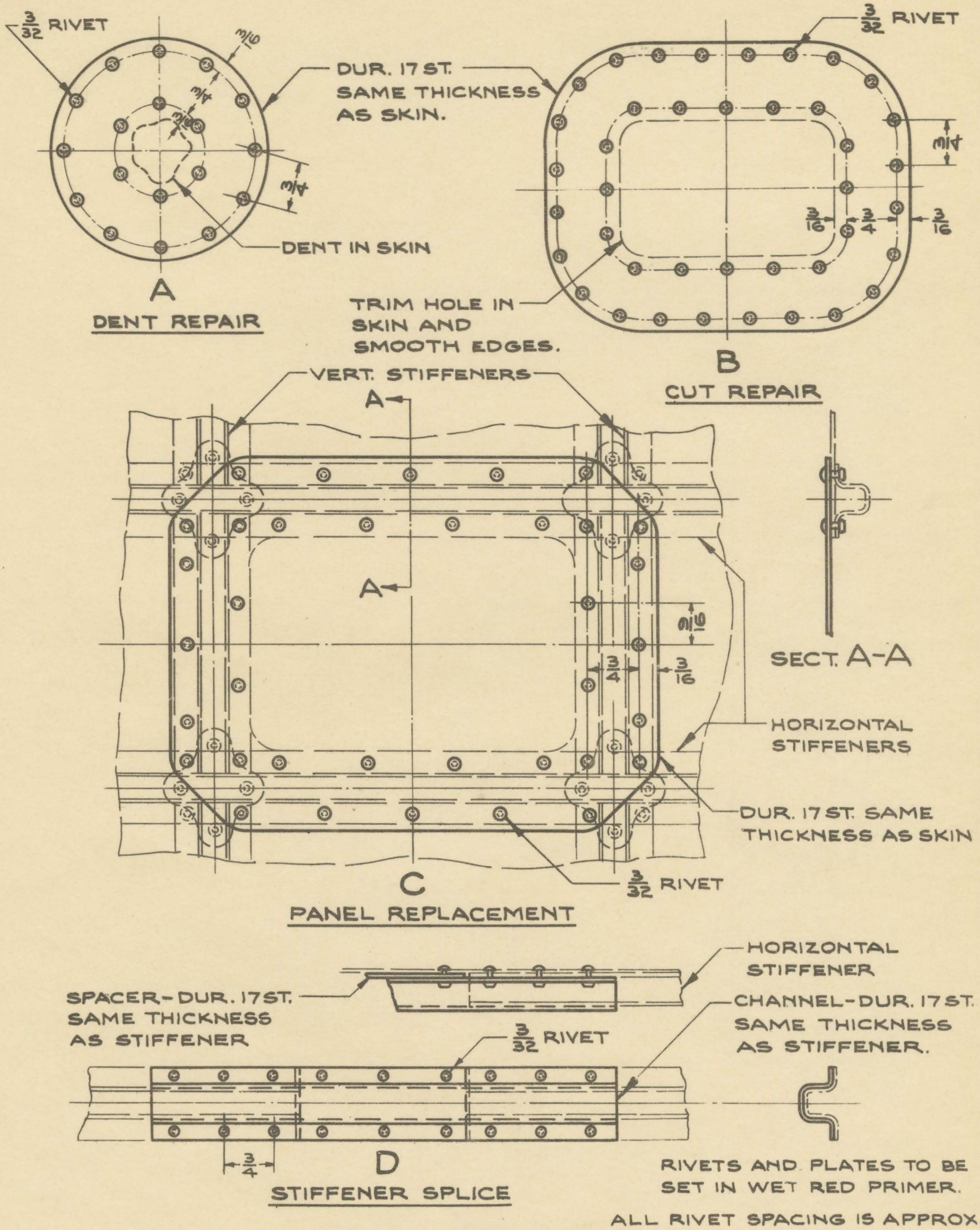


FIG. 2—FUSELAGE REPAIR DIAGRAM

PARTS	ALLOWANCE ON THE DIAMETER OF THE ORIGINAL BOLT	MAXIMUM ALLOWABLE DIAMETER OF OVERSIZE BOLT
SPAR CHORD TERMINALS AT ATTACHMENT OF OUTER WINGS TO WING STUB.	$\frac{1}{8}$ IN.	.896 IN.*
SPAR WEB PLATES AT ATTACHMENT OF OUTER WINGS TO WING STUB	$\frac{1}{16}$	$\frac{7}{16}$
NACELLE TERMINALS AT NACELLE LONGERONS (WING STUB STATIONS 2 & 3)	$\frac{1}{16}$	.578*
UPPER CENTER NACELLE TERMINAL	$\frac{1}{16}$	$\frac{5}{8}$
LOWER CENTER NACELLE TERMINAL	$\frac{1}{16}$	$\frac{9}{16}$
WING TIP TERMINALS	$\frac{1}{16}$	$\frac{3}{8}$
STABILIZER SPAR CHORD TERMINALS	$\frac{1}{16}$	.428*
FIN SPAR CHORD TERMINALS	$\frac{1}{16}$	.322*
STABILIZER AND FIN SPAR WEB PLATES.	$\frac{1}{16}$	$\frac{5}{16}$
ELEVATOR CONNECTOR TUBE	$\frac{1}{16}$	.428*

* FOR TAPER PINS THIS DIMENSION APPLIES TO THE DIAMETER AT THE SMALL END OF THE TAPER.

FIG. 12—OVERSIZE BOLT TOLERANCES

over the skin at the bottom of the body joints at the front and rear spars, etc., BAC tubular rivets are employed; this for the reason that it is impossible to obtain access for bucking standard rivets. During installation or replacement of tubular rivets, the following instructions should be followed: (Several trial installations for practice purposes should be made on scraps of material before an airplane repair is attempted.)

Nail, #21-1676, is inserted into tubular rivet BAC #1352 with the head of the nail extending at the body end of the rivet. The nail end of these two parts in this condition is then inserted into the hole in the hollow rivet setting tool. It will be necessary to part the handles of the setting tool to allow entry of the nail. (Closing the handles will cause a gripping as well as a drawing in action affecting the rivet setting operation.) The rivet thus held in the tool is forced into a hole drilled to receive it. Some tapping with a mallet or similar means may be necessary to draw up or set the rivet head before parting the handles on the tool effecting the riveting operation. In some cases the nail may be broken, in others, it may be advisable to cut the nail rather than break it by the use of a tool. The nail may remain in the rivet by cutting off flush with the head or knocked out and replaced by a standard Parker-Kalon drive screw.

5. Nose Section:- This section of the fuselage assembly is that part forward of the front wing spar or Station 16. It is attached to the center section by means of two circumferential rows of special steel streamline head screws staked after insertion. Special 1/4" and 5/16" dural bolts in shear are employed to tie the four longerons together. This joint in the structure is provided to permit disassembly in exceptional cases and for salvage purposes. No attempt should ever be made to disconnect at this point except in emergency, such as a crash where repairs are impractical and shipment on freight cars is necessary. When this becomes necessary, installation details shown on Dwg. No. 15-2600 should be carefully followed. The nose section consists of the front mail pit, radio equipment compartment, pilot's cabin and the two front passenger seats. Individual items of equipment installed therein are covered in their respective sections in this manual.

6. Center Section:- This section is that part of the assembly between and including the front and rear wing spars. Since these spars are continuous members through the body, all parts attached to or installed within the wing stubs

will be described as being located therein. In brief, the following major units make up the center section--right and left engine nacelles; landing gear; retracting motor and mechanism; fuel tanks, valves and piping; cabin heating equipment; engine controls; battery, and the great majority of electrical system wiring, conduit, junction boxes, etc. If, and when, it becomes necessary to accomplish major repairs to this section it is suggested that the factory be advised relative to the nature of the damage. The major structural members--particularly the spars--forming this section carry loads of very high stress and extreme care should be used during replacements or repairs. The upper and lower spar chord members are of heat treated chrome molybdenum steel tubing square drawn. The vertical and diagonal web members are of rectangular and square cross sections of 17ST dural. Both steel and dural bolts are used in the stub spar structure, the former being secured by castellated nuts and cotters, the latter by dural nuts peened after tightening. When it becomes necessary to make minor repairs, special bolts not more than .025" oversize should be used to obtain the tight fit required. If larger bolts are required, approval should be obtained from the factory. Spar chord splices and terminals are heat treated steel forgings. Except at landing gear fittings, where the gussets are heat treated steel, all gussets are 17ST dural. Side bracing for the spars is obtained by members tied in with the floor beams.

Access doors, removable cover plates, cowling and fillets provided on the center section for removal or inspection of the engine nacelles, outer wing panels, fuel tanks, etc. are covered herein under separate sections.

7. Rear Section.- This section of the fuselage consists of that part aft of the rear wing spar. It is secured to the center section similar to the method outlined for the nose section. As stated for the nose connection, the rear connection should never be broken except in cases of emergency. The following components make up this section--body structure and skin; four rear passenger seats; stewardess seat; passenger door; emergency exit; cupboards; lavatory; rear cargo compartment and door; vertical fin; horizontal stabilizer; tail wheel gear and tail fairing. See Section VI for details of tail wheel and fairing installation. See Section IV for stabilizer, elevator, fin, rudder, and control system installation. See Paragraph 8, this section, for cabin furnishings.

The attachment fittings for the vertical fin and horizontal stabilizer are integral parts of the rear fuselage structure. No adjustment is provided for the fin or stabilizer. Care should be exercised to insure tightness of the bolts used to secure the surfaces to the structure. Four taper bolts, inserted from the front, are used to secure the ends of the right and left stabilizer front spars to the fuselage bulkhead. In addition to these four taper bolts, five 1/4" shear bolts are used on either side. Four taper bolts and four 1/4" shear bolts, inserted from the rear, are used to secure the rear spars to the fuselage structure. Access to the forward bolts is from the inside of the fuselage. Access to the rear bolts is had by removing the dural fillet used at the junction of the surfaces to the body. The vertical fin is attached to the body structure in the same manner employed for the stabilizer. Four taper bolts and three 1/4" shear bolts are used to secure the front and rear beams to the fittings on the fuselage. The forward bolts are inserted from the front and the rear bolts from the rear. Access to the front bolts is from the inside of the body. Access to the rear bolts is by removal of the dural fillets used at the junction of the fin to the body. These fillets are secured by means of machine screws and nut clips.

8. Cabin Furnishings.- The following items are installed within or are considered cabin furnishings:

(a) Passenger Seats: These units are installed five each on the right and left side of a center aisle. To facilitate removal, the cushions and back covers are fastened to the seat structure by means of snap fasteners. The seat legs are secured to fittings on the floor by means of 1/4" bolts and acorn nuts. The seat backs may be reclined approximately 25° from their normal upright position and locked in any desired position. A small handle located under the edge of each seat on the aisle side is provided to operate the locking mechanism. Carbon Tetrachloride or any light petroleum base cleaning fluid should be used for cleaning the cushions and covers.

(b) Individual Reading Lights: Installed on the side wall opposite each seat is a small reading light. One 6-candlepower double contact globe is used in each of these units. The units are secured to the structure by means of machine screws and nut plates. See Section VII for wiring details.

(c) Individual Ash Trays: Installed adjacent to each reading light is an ash tray. It may be removed for cleaning by lifting upward. It is secured to a mounting base by means of two slotted pins. The base is secured to the structure by means of machine screws and nut plates.

(d) Cabin Dome Lights: Two dome light assemblies are provided in the cabin--one above the toilet door, the other on the ceiling above the rear spar. One 15-candlepower double contact globe is used in each of these units. Hinged covers are provided on the units for replacement of a defective globe. One machine screw and nut plate is used to secure the cover.

(e) Individual Ventilators: Located on the cabin wall forward of each window is an individual fresh air ventilator. Operation is effected by turning a knurled knob provided at each unit. They may be adjusted to any desired degree of opening. See Section XI for operation of the main heating and ventilating system.

(f) Lavatory: Installed in the lavatory is a small wash basin, a one-gallon water container with faucet, and a toilet seat. The water container is removable for refilling by lifting upward approximately 6 inches. The bottom of the toilet seat containers should be covered with a quantity of "CN" powder sufficient to cover the bottom to a depth of approximately 1/8". This powder is manufactured by the West Disinfectant Company, a national concern. To overcome a great deal of soiling or sticking to bottoms of the containers, it is suggested that a piece of paper toweling be placed over the bottom prior to putting in the "CN" powder. This keeps the bottoms in better condition and eliminates the use of any water.

(g) Emergency Exit: An emergency exit door, approximately 19" x 24" is provided in the left side of the fuselage at the rear passenger window. It is hinged to the structure and is held shut by means of two sliding bolt action fasteners, operable from the inside of the body only. Care should be used to see that the fasteners are at all times in the locked position.

(h) Cabin Lining: The cabin lining consists of spruce plywood panels secured to clips on the structure by means of Parker-Kalon screws. The panels below the seat arms are covered with Fabrikoid glued to the plywood with casein glue. The panels above the seat arms on the side walls and ceiling are covered with wool broadcloth glued to the plywood with Lauxien #188 glue. The Lauxien glue is insoluble in water, gasoline, carbon tetrachloride, or similar cleaning fluids. At remote points the broadcloth is glued to small metal parts with Goodrich "Plasticon". This should be borne in mind when cleaning the lining at these points for the reasons stated in Paragraph 1, this Section.

(i) Hat Clips and Clothes Rack: Installed on the side walls above each seat is an "Original" hat holder manufactured by the Denning Manufacturing Company, Cleveland, Ohio. Installed also on the cabin walls over each row of seats are clothes racks made of cord netting and shock absorber cord. Only coats and light articles of clothing should be stowed in these racks. Do not place brief cases, books, boxes, and similar articles in these racks as they may become dislodged and drop on the passengers.

SECTION IV

CONTROL SURFACES AND SYSTEMS

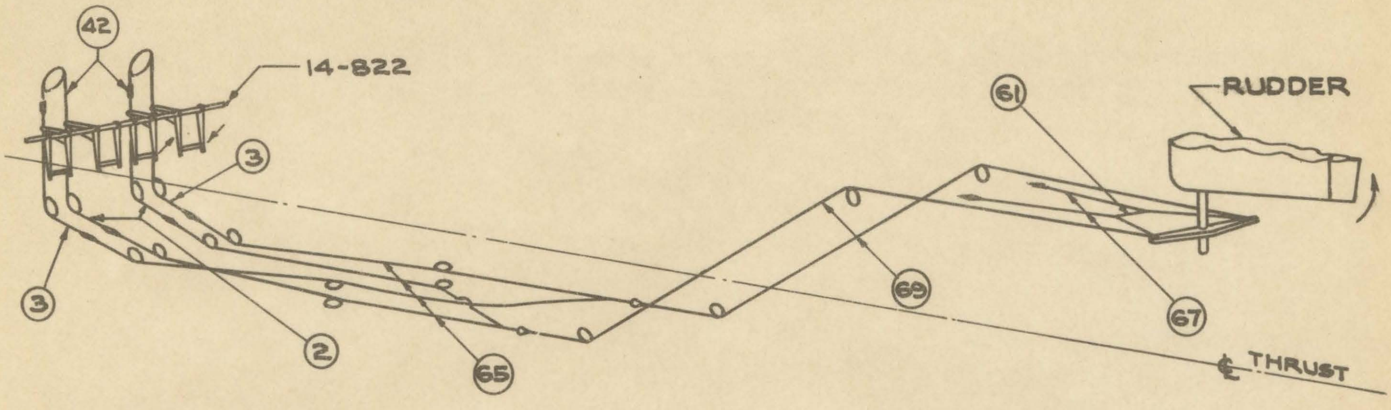
1. General.- The control surfaces consist of the rudder, elevators, and ailerons; aileron flap, rudder flap, and elevator flaps. All surfaces are jig constructed, insuring interchangeability, and hinged with sealed ball bearings, staked into the control hinge fitting to carry the vertical and side loads. Balances of the ailerons are of the Frise type, while the rudder and elevator have "overhung" type. Trailing flaps are used to trim in flight. With the exception of the flaps, all control masts are located within the surface or tail fairing, the latter being removable for access to the rudder and elevator control fittings. Due to the similarity in construction and hingeing of the surfaces they will not be described separately.

The rudder and elevators are operated through torque tubes concentric with the surface hinge line, riveted to the surfaces, and masts which are riveted to the torque tubes. On the elevators, the torque tubes are spliced together at the center with a connecting sleeve and four taper pins. To facilitate removal of the tail surfaces, the torque bearings and their supports are pressed on to the torque tubes, making it necessary to remove only the support bolts.

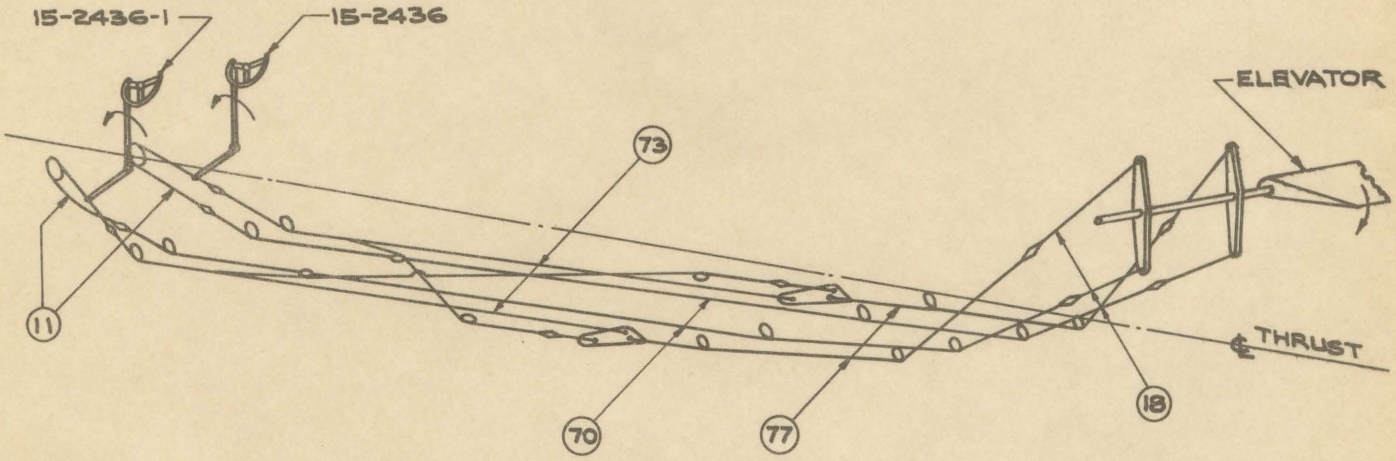
The ailerons are operated by push rods connecting the aileron operating mechanisms with the interior masts. The push rods contain sealed ball bearings at either end and special bolts are used to eliminate lost motion at the connections.

The flight control system consists of the rudder pedals, control column and wheel, aileron operating mechanisms, push rods, and interconnecting cables, as shown on Figure 3; the flap controls, screw mechanisms, and interconnecting cables, as shown on Figure 4.

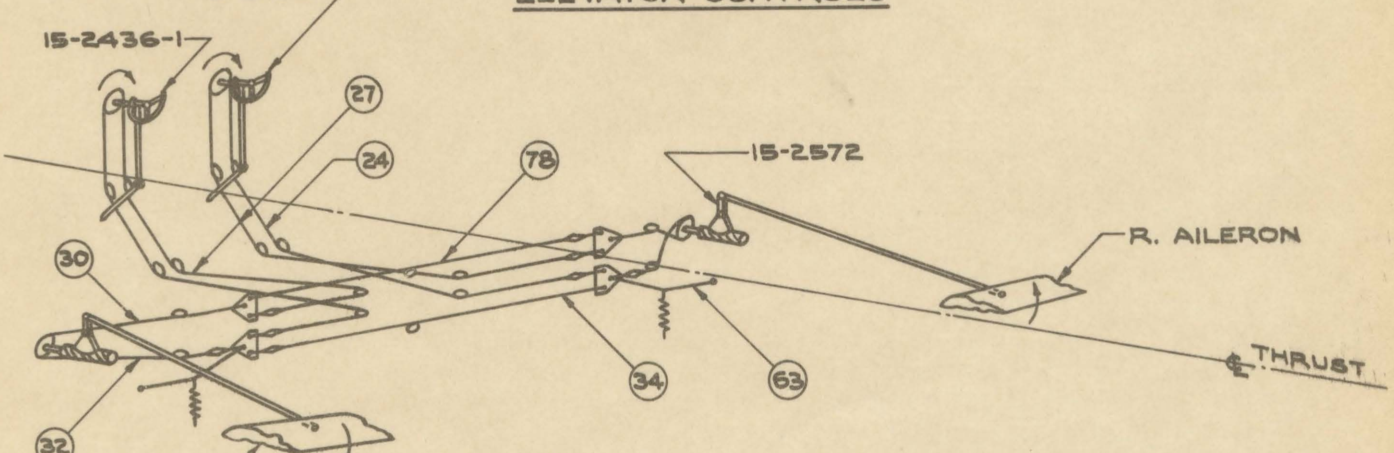
All surface control cables are 5/32" 7 x 19 extra flexible "Trulay", all flap control cables are 1/16" 1 x 19 non-flexible and 3/32" 7 x 7 flexible "Trulay". The cables operating the carburetor air valve, nose shutters, oil cooler, flap controls, and the screw mechanisms are 1/16", and the cables between the screw mechanisms and the flaps are 3/32". All cable adjustments are made by turnbuckles which are located to give the best accessibility.



RUDDER CONTROLS



ELEVATOR CONTROLS



PART Nº'S IN CIRCLES SHOULD BE PRECEDED BY 15-2626 THUS Nº 34 SHOULD BE 15-2626-34

AILERON CONTROLS

FIG. 3 – CONTROL SURFACE CABLES

Micarta, sealed ball-bearing pulleys are used throughout the system. All chafing strips and fairleads are of fiber in order to eliminate metal to metal friction.

Prints of Dwgs. 14-829, 15-2480, 15-2615, and 15-2626, should be obtained for use at overhaul and repair bases. These drawings show in detail the construction and installation of the controls.

2. Rudder Controls:- From the rudder pedals, the cables extend down through the floor of the pilot's cockpit thence aft below the floor of the cabin, toilet, and rear baggage compartment into the tail of the airplane where they are carried to the top of the fuselage and connected to the rudder mast. Adjustment of these cables is made by four turnbuckles, located under the pilot's floor and accessible through the bottom inspection door. With the co-pilot's rudder pedals locked, all four rudder pedal adjustments and the rudder set in neutral, the four cables are tightened together until the tension of each is the same, and the operation of the rudder is both free and firm.

In airplane NC-13319 and all items after NC-13325, spring cartridges have been substituted for the turnbuckles in the rudder buss cables, behind the instrument board. In these airplanes, tension will be taken in the cables as mentioned above, until the spring cartridge is fully extended, then backed off until the spring has receded 7/8". Travel of the rudder is limited to 27° each way by stop cables immediately forward of the rudder, anchored to the top longerons by turnbuckles, and adjustable at this point.

3. Elevator Controls:- From the bottom arms of the control columns, the elevator cables, following the rudder cables, pass back under the cabin floor into the tail section, where they are fastened to the elevator masts. Adjustment of the elevator system is made by means of ten turnbuckles located as follows: four under the pilot's floor, accessible through the inspection door; two under the cabin floor just aft of the rear spar and fastened to the cable joining plates; and four in the tail, immediately forward of the elevator masts. With the crossover cables slack (loosen the turnbuckles under the cabin floor), the other cables are tightened by taking up on the four forward and four rear turnbuckles, keeping the joining plate (just aft the rear spar) approximately in its proper location (Dwg. 15-2480) and keeping the control columns in a vertical position when the elevators are in neutral. After this adjustment, the cross-over cables are tightened to an equal tension. The stops on the elevator cables, located under the pilot's

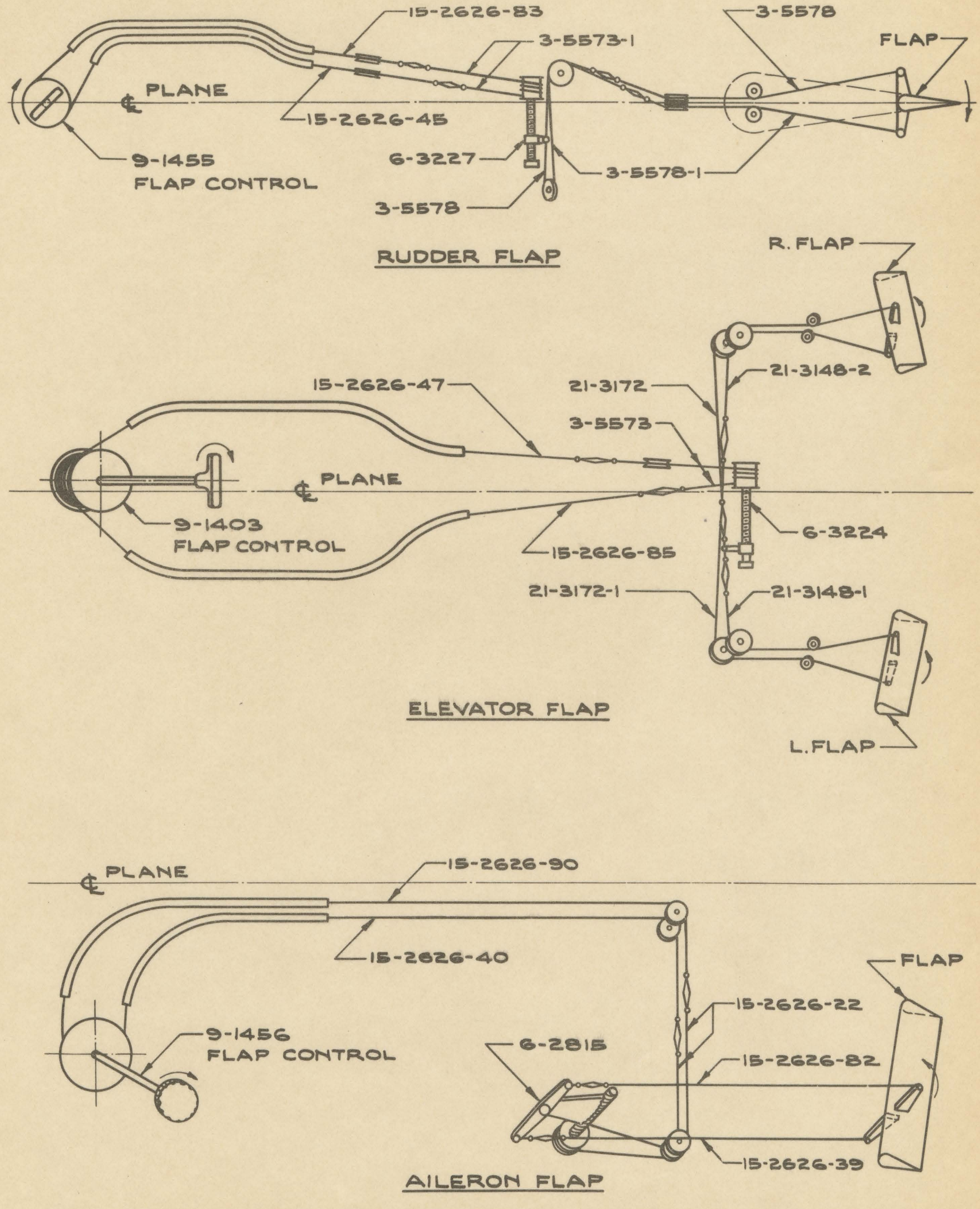


FIG. 4 – CONTROL SURFACE TRIMMING FLAPS DIAGRAM

floor, are then soldered in place to give an elevator travel of 27° each way.

4. Aileron Controls:- The cables for the aileron system are joined to chains at either end, which pass over sprockets on the control wheels, and on the aileron operating mechanisms. From the chains over the control wheel sprockets, the cables pass through the removable covers on the control columns, over pulleys at the hinge points, and aft under the cabin floor to brackets just aft of the rear spar. From this point, they pass through fairleads in the body into the wing stubs, thence into the outer wings to the chains on the aileron operating mechanisms. Adjustment for cable tension is made at the following points: four turnbuckles in the L.H. wing stub aft of the rear spar, accessible through inspection doors in the lower skin; four turnbuckles in the R.H. wing stub, similar access. Before adjusting the aileron cables, the following precautions must be taken: with the control wheels and the ailerons in neutral, the sprocket chains over the wheel sprockets and the aileron mechanism sprockets must be set so that the free ends of each chain are as near opposite each other as possible. With the control wheels in neutral, the ailerons are brought separately to their neutral position. This is done by adjusting the three remaining turnbuckles in each wing stub, with the buss cables slack. After the desired tension is reached in each cable, the buss cables are tightened to an equal tension, care being taken to keep the control wheels and ailerons in neutral.

The aileron stop cables are anchored to the lower chords of the rear stub spars, but have no adjustment of their own. To adjust the travel of the ailerons to 6-5/8" each way (measured from the inner trailing edge of the aileron to the trailing edge of the wing), the four turnbuckles in each stub are readjusted to give the correct location with respect to the stop cables.

The aileron operating mechanism is provided with an adjustment for controlling the mesh clearance between the worm and the worm gear segment. This adjustment controls the amount of play in the ailerons, and after periods of time may have to be reset. To accomplish this adjustment, the lockwire on the center bearing support is removed, and the castle nut on the opposite side loosened until the support is free to rotate. Integral with the bearing support is an eccentric shaft which raises or lowers the segment with respect to the worm. The support is rotated until the desired mesh is obtained, the castle nut tightened and the lockwire replaced by drilling a new hole in the support.

5. Rudder Flap:- The control for this flap is located on the cockpit floor just aft of the control stand. From the control drum under the pilot's floor, the 1/16" cables pass through bowdenite under the cabin floor back to approximately Station 20, thence through fairleads back to the drum on the screw mechanism. From the trunnion on the screw, the 3/32" cables are lead into the fin, thence to the flap masts. Adjustment is made by four turnbuckles: two just forward of the rear drum, and two between the trunnion and the fairlead into the fin. The travel stops are fastened to the screw with taper pins, and originally set to give a flap motion of 30° each way. To rig the system, the forward cables are tightened, with the trunnion and control indicator (on the cockpit floor) set in neutral. The tension in these cables is dependent upon the ease of operation, and can normally be operated best if kept quite loose. With the indicator and screw still in neutral, the rear cables are tightened to bring the rudder flap to neutral, and until its motion is both free and firm. Adjustment for gear mesh clearance in the rudder, elevator, and aileron flap operating mechanisms is made in same manner as that outlined above for the aileron operating mechanism.

6. Elevator Flaps:- The control for these flaps is located on the panel on top of the control stand. The 1/16" cables between the drum and screw are located and adjusted similar to those for the rudder flap. For adjustment of the 3/32" cables there are three turnbuckles: two on the trunnion, and one in the flap buss cable. These are tightened to the correct tension and then readjusted to place the elevator flaps in their neutral position. The travel of the flaps is 30° each way.

7. Aileron Flap:- The control for this flap is located on the cockpit floor to the left of the pilot's control column. The cables for this flap parallel the other flap cables back to a bracket just aft of the rear spar, thence through the body into the left wing stub and outer wing where they are served to the drum on the aileron flap motor. From the mast on the flap motor, the 3/32" cables are lead through the aileron to the mast on the flap. Adjustment of the system is accomplished by four turnbuckles: two in the cables between the flap control in the cockpit and the flap motor in the wing and two fastened to the mast on the flap motor. With the indicator control (in the cockpit) and flap motor (in the wing) set in neutral, the main cables are tightened just enough to insure proper position on the drums. The short cables are then taken up until the motion of the flap is both free and firm.

Stops similar to those on the elevator cables are used to check the travel of the flap. These are soldered in place, after rigging, to give a flap motion of 11/16" each way. They are located in the left wing stub and butt against a reinforced fairlead on the rear spar.

8. Engine Controls:- These include the throttle and mixture controls. Since both are of the push rod-bell crank type, they will not be described separately. From the control stand in the pilot's cockpit, the rods lead down to bell-cranks below the pilot's floor, thence aft to bell-cranks immediately forward of the front spar where they diverge, two leading through the body and stubs to the right nacelle, and two to the left nacelle. These rods are supported by fairleads on the nose ribs just outboard of the leading edge access doors. The rods between the bell-cranks in the nacelles to the carburetors pass through fiber fairleads in the firewall. One end of each rod is adjustable to facilitate synchronizing the throttles and mixtures. The controls are normally set to give 1/4" cushion at each end of the quadrant motion. All bell-cranks are operated on sealed ball bearings giving very little wear and should seldom need adjusting. On the bell crank brackets at the rear of each nacelle are switches for the landing gear warning signals which may occasionally need resetting. These switches are covered in Section VI.

Separate locks are provided on the control stand to hold the throttle and mixture levers in any desired position.

9. Radiator and Shutter Controls:- From the drums in the pilot's control stand, these cables parallel the carburetor control rods out to the inboard side of each nacelle just forward of the front spar, where they are served onto differential drums. In each nacelle the radiator cowl control cables lead from the large drum on top through a fairlead in the firewall up to the drum on the cowl. From the lower drum, the nose shutter cables pass through bowdenite casing to a point on the nose of the engine where they operate the shutters. At the point where the cables pass through the body they are carried through short bowdenite cases, which in the left stub continues past the battery compartment to protect the cables from corrosion. Adjustment in this system is made by turnbuckles located in three groups, one below the control stand, one in each front stub access door, and one forward of each firewall.

10. Carburetor Air Controls:- The cables of this system operate similar to, and are parallel to those mentioned above for the radiators and shutters. From a bracket in each nacelle, the cables lead forward through the firewall to a drum

on top of the carburetor air valve. Turnbuckles are provided below the control stand and in the stub access doors for adjustment of these controls.

11. Lubrication Chart.- Figure 13 shows the important points in the control systems which should be inspected and lubricated periodically. It also shows points in the landing and retracting gear system which require periodic lubrication. For lubrication details of the magnetos, retracting gear motor, starters, and other accessories, it is suggested that service manuals be obtained from the manufacturers of the equipment. Blueprint copies of Figure 13 in actual size, 25½ x 33, will be furnished on request. These large size prints may be desired for placing on shop bulletin boards.

Grease should not be applied directly to control cables as this allows grit to work into the strands and shorten the life of the cable. However, in exceptional cases of friction in the bowdenite casings, graphite or graphite grease should be used.

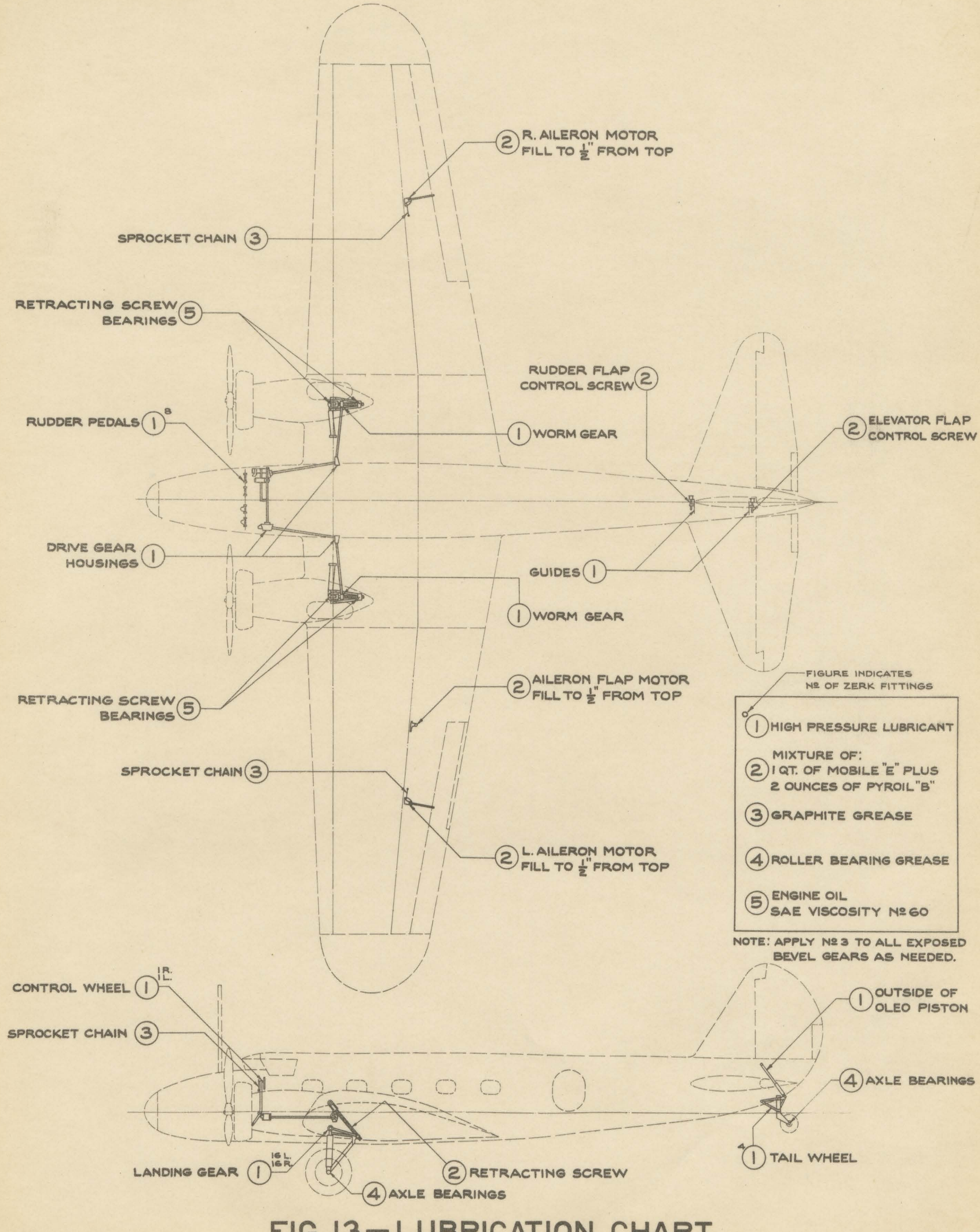


FIG. 13—LUBRICATION CHART

SECTION V.

WING

1. Description: For simplicity the wing is described in three parts, viz. Stubs, Panels, and Tips.

2. Stubs: The stubs form an integral part of the fuselage center section. The spars are continuous members thru the body. See Section III, 6, for detailed description of spar construction. To facilitate inspection at overhaul, the trailing edge of each stub--aft of the rear spar--is removable. This part is secured to the structure at the rear spar by means of machine screws and nut plates. It should be removed only at general overhaul periods or in emergency. Hinged inspection doors are provided in the lower surface of these sections to facilitate inspection and adjustment of the control cables. Dural fillets attached by means of machine screws and nut clips are installed at the junction of the stubs and the fuselage.

3. Panels: The right and left panels are attached to the stub by means of two taper steel bolts at each spar terminal fitting. In addition, seven 3/8" dural bolts are used to insure tightness of these bolts. Access is had by removing the dural cover over the wing joint. During original installation of each panel to the stub, alignment was made by means of a jig, the taper bolt holes reamed, the bolts inserted and tightened. After this, the seven holes thru the webs for the 3/8" bolts were drilled. This procedure insures proper alignment and should be considered when a panel from one airplane is installed on another or when a new panel is used. The main spar fittings are interchangeable. However, care should be used to see that the 3/8" bolt holes are in proper alignment. Ream for oversize bolts if misalignment is noted. New panels are supplied undrilled. See Fig. 12, Section III, for oversize bolt hole tolerances.

The trailing edge of each panel--inboard of the ailerons is removable. It is attached to the rear spar by machine screws and nut plates. Hinged doors are provided in the lower surface for inspection, adjustment, and installation of the control cables.

During overhaul or repair of a wing panel, it should be borne in mind that the materials used in the various component parts are as follows:

Spar Chords	17SRT, square drawn dural
Inner Terminals	Special heat treated steel
Outer Terminals	17ST dural
Vertical and diagonal spar members	17ST barrel sections, dural
Chord Splices	17ST dural
Gussets	17ST dural
Rib Chord Sections	17ST dural drawn from sheet
Rib diagonals, compression	17ST dural square drawn
Rib diagonals, standard ribs	17ST dural square and round

The spars are assembled with 3/16" dural rivets except for steel bolts at terminals and compression ribs. The ends of the round and square tubing used for the standard rib diagonals are flattened to facilitate riveting. Ribs are gusseted to chords and spars with dural rivets. Damaged "barrel" section diagonal members of the outer wing spars may be replaced by rectangular dural 17ST tubes as follows:

1. Replace 2-3/16" x 1" x .049" "barrel" sections with 2-3/16" x 1-3/16" x .058" rectangular tubing (BAC1501-3859).

2. Replace 2-3/16" x 1-29/64" x .049" "barrel" section with 2-3/16" x 1-3/16" x .065" rectangular tube (BAC1501-3860).

Replace the 3/16" rivets attaching the tubes to the gussets by #10-32 AN bolts, or if a tight fit is not obtained use oversize steel bolts (SAE 2330 steel) of a diameter not to exceed .219". See Fig. 12, Section III for oversize tolerances.

Caution - Under no circumstances should holes be drilled in the main spar chord members.

Installed within the leading edge of each panel approximately 6 feet outboard of the stub connection is a special locomotive type landing light and a courtesy light. A special glass moulded to the contour of the leading edge covers the compartment. This glass must be removed to adjust the reflector. Extreme care must be used when tightening the turnbuckle in the strap holding the glass in place. A small watertight door is provided on the upper surface of the leading edge to permit replacement of bulbs.

4. Tips: To facilitate repair or replacement of a damaged tip, these units are removable. Four 1/4" bolts are employed--2 at the front and 2 at the rear spar--to secure the tip to the panel. Machine screws and nut clips are used to fasten the top and bottom covering. A removable plate covers the front opening. Two flush type navigation lights are installed in each tip--one each on the upper and lower surfaces.

SECTION VI

LANDING GEAR

1. Description.- Several features not heretofore employed on Boeing commercial aircraft have been incorporated in the landing gear of these airplanes; viz. manual-electric retractile operation, air-oil shock absorber struts, hydraulic brakes, and low pressure tires and tubes for main and tail gear wheels. The successful operation and dependability of these, as well as other features of the gear, depends to a great degree on proper adjustment, care, and maintenance. The retracting mechanism is shown diagrammatically by Figure 5 and consists essentially of the following units: a reversible-action, double-acting ratchet-type actuating handle on right side of pilot's cockpit; positive type engaging clutches with actuating lever located on control stand in pilot's cockpit; and a series of torque tubes carried in ball bearing gears for driving the retracting screws.

Extreme care must be exercised during inspection and servicing of the retracting mechanism to see that dirt, water, and heavy grease is not allowed to collect on the gears or screws. The screw guards should be carefully checked to ascertain whether or not they are functioning properly. The "Thermoid" universals and splined shafts in the drive shaft to screw worm gears should also be inspected frequently for undue wear. The retracting screw worm and motor reduction gear boxes should be properly lubricated periodically to insure proper operation. A thin coating of graphite grease is recommended for the spur gears in the system. Wadhams winter grade "Badger" gear grease, or equivalent, is recommended for the retracting screws.

2. Manual Retraction.- For this operation, it is only necessary to set the trigger control knob on actuation handle for UP or DOWN movement and actuate the lever fore and aft. The gear ratio between the handle and screws requires approximately 125 full strokes to fully raise or lower the gear. The handle operates the drive mechanism in both directions of motion. The clutch employed for manual drive is normally held in engagement by a spring. It remains in engagement except when the motor control handle is raised or depressed for electric operation. This arrangement causes the motor to be disengaged at all times except when motor operation is desired. By actuating the motor clutch control through approximately 50% of its travel--for UP or DOWN movement--the manual drive clutch is disengaged and the motor drive clutch engaged. Further movement depresses a pair of switches, causing the motor to operate for selected direction. When the hand is removed, a spring automatically returns the handle to neutral, disengaging the motor clutch and engaging the

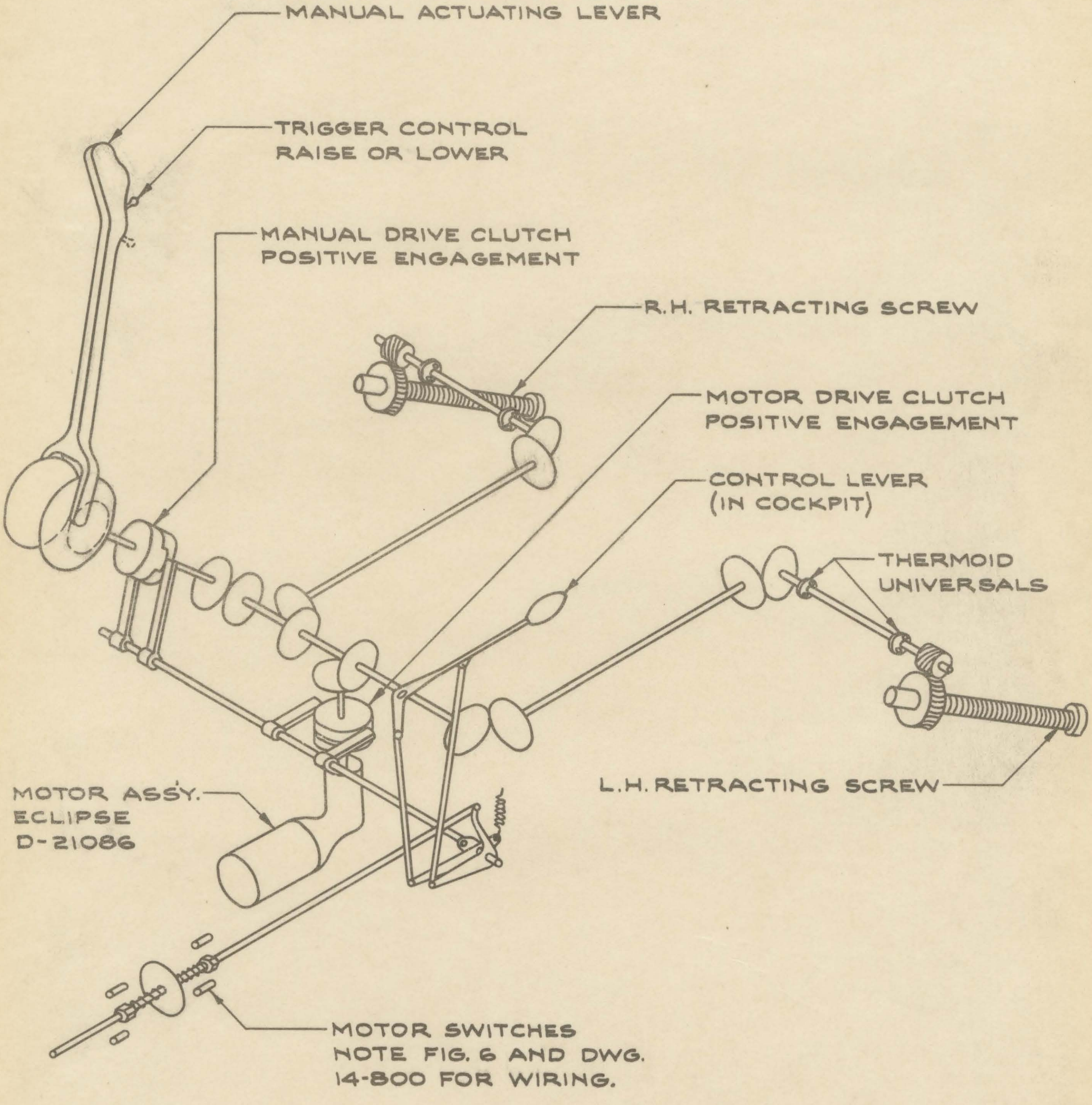


FIG. 5—RETRACTING GEAR DIAGRAM

manual clutch. Access to the motor, switches, clutches, and gears may be had through a door in the bottom of fuselage below pilots floor. Additional access for inspection or removal of certain parts may be had by removing inspection plates on either side of fuselage opposite the motor and cross drive shaft. These doors are secured by means of flat head screws and nut plates.

3. Electric Retraction.- This consists of an Eclipse M-2615, Dwg. No. F-26544, reversible type, series wound motor, mounted on a reduction gear case incorporating a multiple disk safety clutch. This clutch is adjusted to slip at 35 foot pounds and the gear ratio between the armature and drive shaft is 27 to 1. It is adjusted and set by the manufacturer during original assembly and should operate satisfactorily over extended periods of time. Its design is essentially the same as that employed in the Eclipse electric inertia starter. Mounted directly on the motor drive shaft is a second positive type clutch, actuated by means of the control handle described above. Two heavy duty switches are employed to operate the motor for UP, and two for DOWN, gear movement. If, for any reason, it is desired to reverse the direction of gear movement during motor operation, it is only necessary to throw the lever to the opposite side of neutral.

Extreme diligence and care must be used during adjustment of the motor control switches. A spring loaded disk is employed to depress the switches in pairs. Adjustment for moment of contact of the switches can be accomplished by varying the tension of the actuating disk springs. Lock nuts are provided on the disk actuating rod for this purpose. Unless the clutch engaging spring is depressed before the motor starts, the clutch may not become fully engaged. It is suggested that personnel charged with the adjustment and care of this equipment become familiar with its operation before attempting readjustments. The actuating disks were properly adjusted during final assembly and original test of the airplane and should remain in adjustment over extended periods of time. To facilitate removal or replacement of the motor switches 10-32 bolts and castellated nuts are employed to secure these units to mounting brackets.

4. Position Indicator and Warning Devices.- This system consists of a Pioneer landing gear position indicator located on pilot's instrument board; a bevel gear and flexible drive shaft for driving the indicator; two red bulls eye lights located on instrument board; a 12-volt Klaxon located on bulkhead just aft of pilot's head; two "release for contact" and two "depress for contact" switches located one each in rear of each nacelle. The complete installation is shown

diagrammatically by Figure 6. It functions essentially as follows:

(a) Switches "A" are open only when the gear is in full down position.

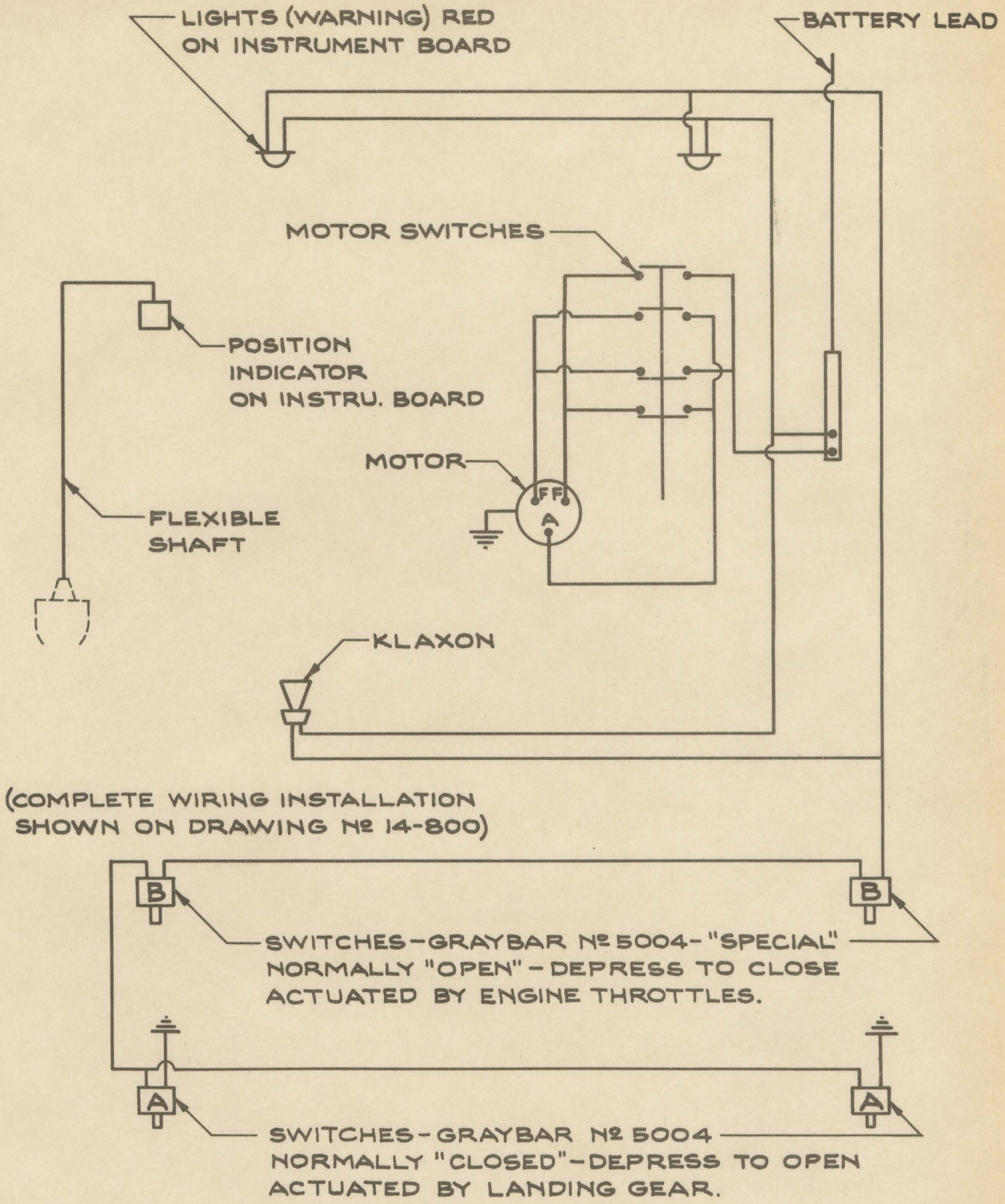
(b) Switches "B" are closed only when engine throttles are closed.

After take-off and immediately the gear starts up, switches "A" automatically close. With the throttles open, switches "B" are open. The indicator pointer, actuated by a direct driven flexible shaft indicates the exact position of the gear. Closing both throttles when the gear is in any but the full down position, completes an electric circuit to bulls eye lights and Klaxon, warning the pilot audibly and visually that the wheels are not full down. Once switches "A" and "B" are properly adjusted, little or no difficulty should be encountered. Adjustment of these is effected by properly positioning the switch bodies in the anchor brackets and/or by shimming. Especial attention is invited to the fact that if the drive mechanism to one side of gear fails to lower either wheel, the warning lights will be ON and Klaxon sound. This warns against landing with one wheel down and the other partially or full up. Note wiring diagram No. 14-800 for details of switches, and size and location of conductors.

5. Oleo Struts, Main and Tail Gear.- These units differ from those on previous Boeing designs in that no springs are used. When the oleos are in the fully extended condition--for landing--the majority of the shock absorbing work is accomplished by the oil mixture. When in the compressed condition--for taxiing--the majority of the work is accomplished by the compressed air. For best operating results, it is absolutely essential that the required amount of liquid and air pressure be maintained. A mixture of two-thirds castor oil and one-third Butyl alcohol should be used to fill the oleos. Filling is accomplished by means of a small funnel or grease gun through filler hole near upper end of strut adjacent to air valve. All air should be expelled from the unit prior to removal of filler hole plug. With the oleos in the fully compressed condition, liquid should be added until it is level with the filler hole. Extreme care must be used when installing and tightening the filler hole plug. A special copper-asbestos gasket under the grooved head plug is required to prevent leakage.

With the liquid at the proper level and the full load, less pilots and payload, of the airplane on the units, they may be inflated by means of air under very high pressure, as follows:

(a) Landing gear oleos to approximately 470 lbs., or until the piston is extended approximately 2-3/4 in.



NOTE:
SWITCHES B MAY BE IDENTIFIED BY A RED BAND PAINTED AROUND SWITCH BODY.

FIG. 6 – WIRING DIAGRAM – WARNING DEVICES

(b) Tail wheel oleo to approximately 380 lbs., or until piston is extended approximately 4 in.

Before inflating a completely deflated unit, the airplane should be jacked up so that the piston clears the bottom of the cylinder about 1/4", otherwise the piston cup may be blown off.

Do not inflate the units with carbon dioxide or oxygen. It is recommended that standard oxygen or CO_2 cylinders filled with compressed air at 2000 lb./sq.in. be used for inflating the units.

"Preston" metal seat valves and caps are used to insure against air leakage. The conventional rubber seat valves give unsatisfactory service for the pressure involved; however, they may be used if no spare Preston valves are available. If, in case of emergency, it is impossible to pump up the oleos to the recommended pressures, no serious difficulties should be encountered from taxiing or landing. The oleos would only appear rough due to piston bottoming while taxiing. No appreciable difference would be noted during landing.

When it becomes necessary to disassemble the units for overhaul or check, extreme care should be used to prevent any damage to the special rubber compound cups employed. Absolute cleanliness of all parts is essential prior to assembly. All joints must be sealed with litharge and glycerine. Assembly drawings Nos. 5-580 and 7-922 should be referred to during major overhaul or disassembly of these units.

6. Wheels, and Tires - Main and Tail Gear.- The landing wheels are manufactured by the Warner Aircraft Corporation, Detroit, Michigan. The wheel proper is a one-piece alloy casting, equipped with Timken roller bearings and a removable "Gunite" metal brake drum. A removable stub axle is press-fitted to the axle sleeve. To a flange on this sleeve is bolted the brake beam on which are mounted the hydraulic cylinders and brake shoes. The wheels are of drop center design, equipped with 42 x 15-16 tubes and non-skid casings. Removal of wheel is accomplished by removing the outer fairing disc and grease retaining cap. The outer bearing retaining nut is then removed by means of an adjustable spanner wrench--Warner Part No. FA-101-1--furnished for that purpose. The wheel can then be pulled off the stub axle. The inner bearing cone remains as part of the wheel hub assembly, being retained by the inner grease seal, which is a press fit in the hub. These parts can readily be pressed out of the hub when necessary.

Instructions for Mounting and Demounting Low Pressure Airplane Tires on Drop-center Rims:

Mounting Instructions - (a) Examine wheel flanges. Remove any sharp burrs with a file. Mount first bead of casing on wheel at the side opposite brake drum. Method of application is a button-holing process, the necessary slack being obtained by keeping the applied part of bead as far into the well of rim as possible. Use a flat, thin, smooth ended tool if necessary.

(b) Remove core from valve in tube and evacuate practically all the air. Replace valve core and insert tube in casing with valve stem pointed outward and positioned adjacent to the valve hole in the rim. Inflate tube until it is well rounded out but not stretched. Work the tube over rim flange preferably using a hammer as a tool, holding the hammer head in the hand and pushing the tube with the end of handle, progressively around the tube. Position valve stem at hole and pull up with rim nut, as there is great danger of pinching tube when mounting second bead.

(c) Mount second bead as instructed in (a) progressing around bead in short advances. Do not sink tip of tool far under casing as there is danger of injuring tube.

(d) Inflate to 25 lbs. pressure and tighten valve stem rim nut.

Demounting Instructions -

(a) Remove rim nut and valve core. Allow tube to completely deflate.

(b) Loosen tire beads from both sides of wheel.

(c) Remove bead from rim on the valve side of wheel using two thin flat, smooth ended tools. The methods of removing is a button-holing process, the necessary bead slack being obtained by keeping the part of bead not yet removed from the rim as far into the well as possible.

(d) Remove tube making sure that there are no sharp burrs on the rim flange.

(e) Remove second bead from the wheel as described in (c).

The above instructions apply to the landing gear wheel tires only. The tail wheel tires may be slipped off the wheel by removal of one flange. Inflation pressure however as recommended by the tire manufacturer is 25 lbs. for both the landing and tail gear tires.

Wheel Installation and Bearing Adjustment: Extreme care should be exercised when greasing the bearings prior to installation of the wheels. The tapered roller bearings should be greased with a heavy fiber grease with a high melting point (350° to 450° F.) "Mobile Grease #5", "Opaline Universal Grease", or the equivalent, is satisfactory. If a light grease is used, it will thin out at high temperatures and foul the brake lining. In packing the inner bearing cone it is well to lay the wheel with its outer face down and hold the inner bearing cone so that it is centered in place, packing the grease between the cone and the grease seal. This will keep the bearing centered during assembly and prevent any tendency for it to kant. Under no circumstance should any grease be packed in the space between the inner and outer bearings. After packing the inner bearing, the wheel should be carefully slipped over the stub axle until the inner bearing rests against the shoulder on the axle. The outer bearing is then slipped on, grease worked in, and the tongued washer and retaining nut installed. Bearing adjustment is then accomplished as follows: draw up the nut until the wheel drags, then back off (approximately 1/4 turn) until the wheel turns freely, then cotter. Brake drag should not be mistaken for bearing tightness during bearing adjustment. Install the outer grease retaining cap and fairing disc.

The tail wheel installation consists of a welded steel tube support, a full swivel ball and roller bearing wheel fork with a coil spring centering device, and a Timken roller bearing tail wheel, size 16 x 7-3. The complete assembly is attached to the rear fuselage bulkhead by means of three 1/2-inch bolts--one at each lower longeron and one at upper oleo terminal fitting. All pinned joints subject to wear are provided with steel bushings and Zerk lubricator fittings. Similar fittings are also provided for greasing the roller and ball bearings in the fork. A removable streamline tail piece encloses the complete assembly, except the wheel. A laced leather boot excludes dust and mud from the assembly. Access to the fork, Zerks, and oleo filler plug may be had by removing an inspection plate on either side of the tail piece. Machine screws and nut plates are employed to secure these plates. Eight 1/4" bolts and castellated nuts are employed--four on either side--to secure the tail piece to the rear bulkhead. A plug and socket is employed to break the tail light conductor to facilitate removal of complete tail piece assembly.

The tail light is faired into the rearmost tip. For major details of support and fork assemblies refer to drawings No.6-2545, 14-809, and 15-2433.

7. Hydraulic Brake System: This system is shown diagrammatically by Figure 7. Each wheel is equipped with two hydraulic cylinders actuating two separate brake shoes. The upper cylinder operates the top of the front shoe and the lower, the bottom of the rear shoe. The other ends of the shoes are anchored by means of small rods bearing against adjusting pistons, threaded into the corresponding ends of the hydraulic cylinders. Each shoe is guided by a spool and bolt at its center and is further located by a stop screw which contacts the inside of the shoe near the operating end. Black bands are painted on brake system piping for identification purposes.

Brake Shoe Replacement and Adjustment: Brake shoes are equipped with special lining which is moulded to the contour of the shoe. After assembly, the lining is ground to size, to assure full contact with the drums. It is, therefore, advisable, when relining is necessary, to secure shoes with new lining from the Warner Aircraft Corporation, or to return the old shoes for relining and reconditioning. Adjustment of new shoes will be necessary after they are first "run in", and occasionally thereafter to compensate for wear and to insure equal braking effort from both wheels. To remove brake shoes, it is first necessary to remove the wheel. Release the brake shoe springs and remove the guidebolts and washer at the center of each brake shoe and brake shoe clevis pins. Before replacing the shoes, a very small amount of thin graphite grease should be used on the clevis pins and the end of the piston and anchor rods. Care should be used to prevent any grease from getting on the brake lining.

In a "closed fluid" system of hydraulic actuation, as employed on these airplanes, it is absolutely necessary to open valves A, Figure 7, which lock the system, when brake shoe adjustment is made; this to avoid "softness" and the possibility of any vacuum forming in the system. Always close the A valves after adjustment is completed. Bleeding should not be necessary as a result of change of adjustment but it is well to "feel out" the system to ascertain that sufficient fluid has been drawn in to compensate for any increased capacity of the wheel cylinders, using reservoir pump if necessary to eliminate softness.

A fluid of approximately 50% castor oil and 50% diacetone alcohol, or the equivalent, must be used in the system.

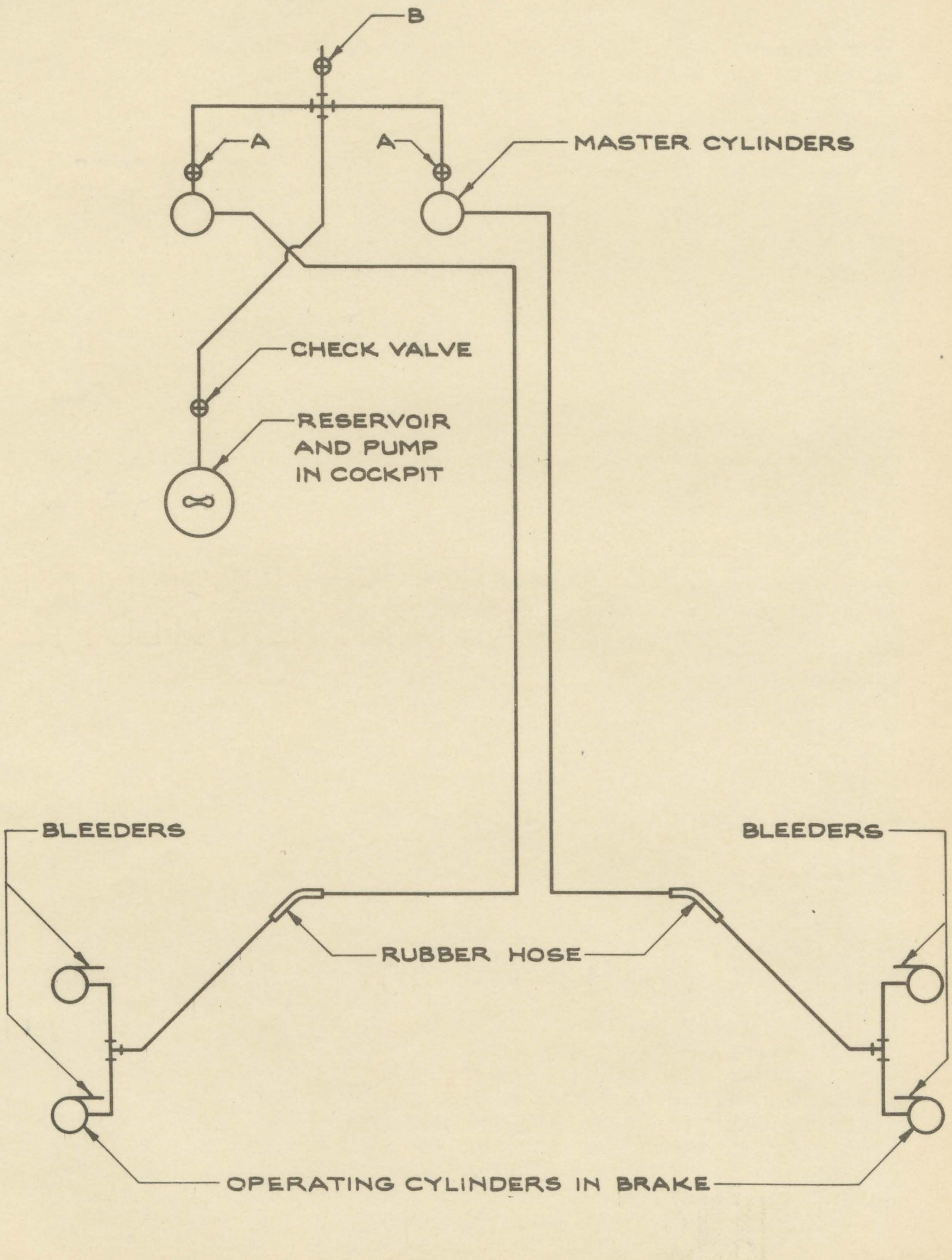


FIG. 7—HYDRAULIC BRAKE SYSTEM DIAGRAM

To adjust the brakes, proceed as follows: Remove the outer wheel fairing. The release stop screws and adjusting pistons are now accessible through the wheel spokes. With a short end wrench, turn the release stop screw until the clearance between the brake shoe and drum is approximately .006"-.008" at the feeler gauge slot nearest the release stop screw. Using a special wrench (Warner Part No. FA-103) furnished for the purpose, screw out the adjusting piston until the clearance between the brake shoe and drum is .010"-.012" at both feeler gauge slots, readjusting the release stop screw if necessary. When the correct adjustment is obtained, be sure the brake shoe is approximately centered with relation to the centralizing spool. Repeat the above operation until both shoes in each wheel are properly adjusted to give clearance of .010" to .012".

The wheel cylinders contain an operating piston, the adjusting piston (threaded into the cylinder), a spring and two rubber piston cups. They are closed on the operating end with a dust cap and the adjusting piston is locked with a special clip. It is important that the rubber piston cups are clean and that the operating piston is free from scratches. Cylinder walls should be inspected for scores. The adjusting piston should never be rotated so that its ears extend more than 1/2" beyond the end of the cylinder. Both rubber cups must be removed and assembled through the operating end of the cylinders, as the threads at the opposite end of the cylinder may damage the cup lips. Coat the rubber cups and piston with castor oil to assist insertion.

The system should be filled by actuating the pump in the reservoir. This unit is located to the left of pilot's seat and connected to the master cylinders by means of a 1/4" copper tube. One each master cylinder is located just forward of the pilot's right and left rudder stirrup and actuated by the brake pedals. No brake pedals are provided for the copilot. With reference to Figure 3, the system should be filled and adjusted as follows: open valves "A" and remove plugs from wheel cylinder bleeders. Pump liquid into system until it runs out of lower wheel cylinder bleeder. Plug these and pump until liquid runs out of upper wheel cylinder bleeders. Plug these, and open valve "B". Pump until fluid runs out of valve "B" outlet, making certain that the brake pedals are in full aft position. Close valves "A" and "B", and test for softness. If air appears to be in lines, open valves "A" and "B" and press lightly on pedals until fluid starts to overflow at "B". Close "B". Pump gently from reservoir until pedals are back to within 3/32" of pedal stops which will give approximately 3/4" play at the top of brake pedal then close valve "A".

If the system is filled to absolute capacity by pumping until the pedals are all the way back against stops, it is possible that the fluid might expand due to heat or extreme warm weather and cause the brake shoes to drag or in extreme cases to bind.

Special Note: All concerned are warned against tilting the brake pedals aft on the first 20 airplanes, NC 13301 to 13320 inclusive. A solid connection was provided on these planes between the brake pedals and the master cylinders. Pulling back on the pedals--when and if the cylinders are not sufficiently filled--causes air to be drawn into cylinders past rubber cups. A special connection--operable under compression only--is used on subsequent airplanes.

After initial filling, or whenever a line is disconnected, it is necessary to "bleed" the system. Always bleed the lower wheel cylinders first. Each bleeder tube is closed with a pipe plug. When tightening or loosening these plugs, two wrenches should be used: one to hold the tube body and the other to turn the plug. During bleeding of the system, it is well to replace the wheel cylinder bleeder tube plugs with 1/4" hose nipples; this to salvage excess fluid by means of a short length of rubber hose secured to the nipples.

Parking Brake: This unit consists of a ratchet and pawl actuated by a lever projecting thru a slot in instrument board near left end. The function of the lever is to engage the ratchet and pawl when raised ("ON") and disengage them when lowered ("OFF"). It is held in either position by means of small coil springs. To hold the brakes in the ON or applied condition, it is necessary to raise the lever and depress the brake pedals simultaneously as far as possible. The ratchets and pawls hold them in this position. To release, depress the pedals simultaneously a slight amount and lower the lever. The pedals will then return to normal. For details of brake operating mechanism see Dwg. 14-822.

8. Axle Bearings, Jack Pads, etc: The special attention of Overhaul and Repair personnel is called to the design and installation of the axle bearings on lower member of front spar. The bronze bearings--bolted to spar member--are machine turned in pairs. This to insure a perfect fit with the upper bearings of the strut and oleo leg. When bolting the two bronze halves to the spar member extreme care must be used to prevent squeezing the bronze bearing

out of round. Even tho filler plugs are provided in the spar member, caution should be used. It is imperative that a proper fit be made during installation of these bearings to preclude any possibility of binding. Binding will cause stiff operation of the gear and also may cause a very undesirable twisting condition to the spar member. These bearings should be hand fitted before the wheels are installed. They should also be inspected and greased periodically.

Jack Pads--one each on lower spar member--are provided for lifting the complete airplane. With jacks of sufficient capacity the entire airplane may be raised for removal of wheels or gear or for operating the retracting mechanism.

Special eye bolts are used at lower connection of oleo strut to axle. These bolts provide a convenient point for attaching towing gear.

SECTION VII

ELECTRICAL SYSTEM

1. Description: The electrical system employed on these airplanes is a one-wire, negative-ground return, fused-circuit installation. Cables are strung thru and shielded by means of solid aluminum tubing, or Breeze copper braided flexible, conduit. In congested and inaccessible areas short lengths of braid-shielded cable are employed. Cables, insofar as possible, are grouped together in single conduits. This simplifies tracing a circuit or pulling in a new wire. Boeing standard type connector panels and junction boxes are used throughout to facilitate installation, testing and disassembly. Due to the large amount of electrical apparatus employed in these airplanes it was in some instances exceedingly difficult to provide junction boxes of large dimensions. Space allotted for these units was held to a minimum and in many instances boxes, panels and shield covers were designed to fit the space available rather than to the best arrangement for service and maintenance. In addition to each length of cable in the system being identified by a tag secured near each end, identification diagrams are pasted in the lids of boxes and shielding covers. These diagrams show the entrance of each cable, the posts to which it is attached and the circuit of which it is a part.

Note: On account of the large number of alterations and minor changes accomplished just prior to delivery of the first series of these airplanes, identification diagrams were not installed on airplanes, D.ofC.#13301 to 13312. They were installed however in subsequent articles. Diagrams will be supplied for all planes already delivered.

Since there are some 90 odd different items of electrical equipment as well as more than 250 cables employed in these airplanes, a resume of the main circuits will be given to assist those charged with the proper upkeep of the system. In some instances it is felt that separate diagrams or sketches can be used to advantage for checking or servicing certain circuits. These are included in the respective sections herein viz., Landing gear, Radio Telephone System, etc. The installation of equipment units, conduit and junction boxes is shown in detail on dwg. 15-2516.

2. Generator: An Eclipse M-2719, 15 Volt, 25 ampere, double voltage dynamotor-generator is installed on the left engine. On account of the extreme height and weight of this machine, external supports were required. These consist of

a band clamped around the body of the machine and two tubular braces employed between the band and engine mount studs. To facilitate disconnection of the eight electrical conductors to the machine, a special plug and jack assembly is used. The jack half of the assembly is attached to the side of the generator and all conductors are attached to bronze clips provided therein. The high voltage leads enter a separate compartment for protection from the low voltage leads. The plug half of the assembly is secured to the jack half by means of a spring catch. Two sections of flexible conduit are employed to shield the conductors attached to the plug assembly--one section of 1/2" I.D. for the two high voltage leads to the fuse box and one section of 3/4" I.D. for the 6 low voltage leads to the dynamotor change over switch. For wiring details of the plug assembly, see Fig. 8.

The operation of the dynamotor-generator is as follows: Until the engine is turned up to approximately 1100 RPM the armature shaft is disconnected from the engine drive shaft. At approximately this speed an automatic clutch incorporated in the unit engages, causing the machine to be driven by the engine. The generator drive on Wasp engines turns 1½ crankshaft speed, therefore, the armature actually turns approximately 1600 RPM when the engine is turning 1100 RPM. This should be taken into consideration during bench testing of the generators. The employment of the clutch permits battery operation of the machine as a dynamotor when the engine is idling or not running. A special change over switch, operable by a remote control from the pilot's cabin, is used in the circuit to accomodate this operation. A solenoid switch, controlled by a relay in the radio system, is also employed in the main battery circuit for dynamotor operation. The High Voltage circuit is explained in Section XIII.

3. Battery: A special U.A.L. rebuilt 12-volt 68-ampere-hour battery is installed in a metal container located in the leading edge of the left wing stub. A hinged cover is provided over this compartment. A fiber cover is provided over the battery container to decrease possibility of a dead short across the battery terminals in case of a crash. A short length of #2 cable is installed between the positive terminal of the battery and a WECO 705-A master cutout switch located on the side of the battery container. A second short length of #2 cable is installed between the negative terminal of the battery and the wing stub structure for grounding the system. A 1/16" cable control, operable in one direction only, for breaking the circuit was installed between the 705-A switch lever and the pilot's cabin. This arrangement was employed

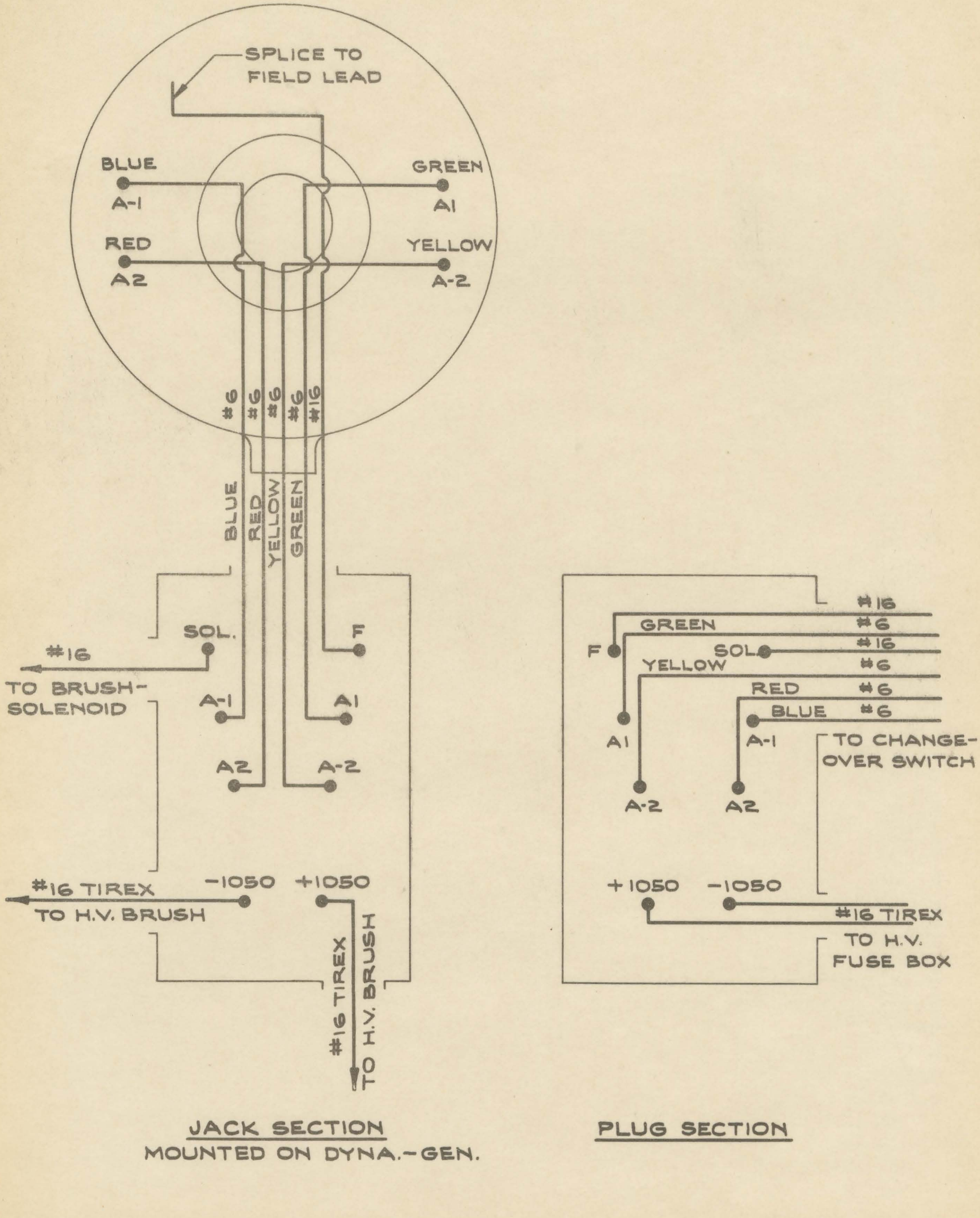


FIG. 8—WIRING DIAGRAM—DYNAMOTOR GENERATOR

on approximately the first 30 airplanes viz. NC13301 to 13330. As this manual is being prepared steps are being taken to install an arens control, operable in both directions, on subsequent airplanes. Included in the 705-A switch is a second set of contacts for breaking the generator field circuit. The use of the master switch provides a means of disconnecting the battery from the electrical system and cutting out the generator. It should be used in case of a short circuit in the system or if and when a forced landing is effected on dangerously rough terrain. Vents and drains are provided in the battery container to permit entrance of air and exit of any liquid spilled out of the cells. All structural members in and adjacent to the battery compartment are sprayed with coats of acid proof paint. "Black Asphaltum" paint obtainable from Berry Bros. or equivalent should be used for this purpose.

4. Control Box: An Eclipse CB-68AC2 plug-in type control box and mounting base assembly is installed immediately ahead of the fire wall in the left nacelle. This assembly permits removal or replacement of a box without disconnecting any cables. Four plugs on the box match up with four clips in the base. The two are held together by means of a spring catch.

Note: Use extreme care when installing a box on the mounting base--if the master battery switch is ON--to insure against short circuiting the coils and conductors in the box. Even though dowel pins are employed in the four corners of the box to prevent installation in any but the correct position, it is possible to place a box on a mount and have the plugs and clips make contact before the dowels are seated. The forward outboard corner of each box and base installed subsequent to and including airplane NC #13312 is painted red. These red markings should be matched when a box is placed on a mount.

Installed within the mounting base is one each 1 mfd. electrolytic condenser, a special shunt and a test jack. The condenser is connected between the B + binding post and ground. The shunt is installed in the main line from the generator. Two No.18 conductors are run between the shunt terminals and an ammeter located on the main instrument board. This arrangement eliminates the necessity of running heavy load carrying conductors to the pilot's cabin. Description of the ammeter will be found in Section XII. The test jack is provided for checking the generator voltage by means of an external voltmeter. The Yaxley jack installed in the bases on airplanes NC #13301 to 13318 inclusive provided a means for checking voltage only with the battery in the circuit. As previously explained, operation of the master battery cut-out switch not only disconnects the battery from the electrical system but also breaks the general field circuit. As a means for determining generator voltage with no load applied, a WECO 215A jack is installed in the base on airplane NC #13319 and subsequent articles. This jack is so constructed that insertion of the test set plug (WEC047-A) closes a pair of contacts which are connected in parallel with the field lead contacts in the master cut-out switch.

Detailed maintenance and service instructions for the battery, generator and control box are contained in Boeing Engineering Document #D-485. Copies of these instructions will be furnished on request.

5. Fuses: Bussman Type 4AG fuses are used for fusing all low voltage circuits in the electrical system including the radio circuits. A single master fuse panel is installed on the right side of the pilot's cockpit. An easily removable cover is used over this panel to facilitate replacement of a blown fuse. Adjacent to and just above the main box is a spare fuse box, in which is carried an ample supply of replacement fuses. All circuits passing thru the main fuse box are identified by the names of the circuits and fuse ratings milled into the bakelite panel. Fuse ratings are also milled in the spare fuse box panel. 5, 10, and 30 ampere fuses are used in the main circuits.

A separate panel with a hinged cover is installed on the sub instrument board for radio system fuses. 4AG fuses of 5, 15, 20, and 30 ampere capacities are employed in the radio circuits. Spares are carried in the spare box referred to above. 3AG, 1-ampere capacity, fuses are used in the transmitter high voltage circuit. These are covered in Section XIII.

6. Landing Gear Circuit.--The operation of the landing gear retracting motor and switches is covered in Section VI, Paragraph 5. The wiring is shown on Figure 6 and Drawing #14-800.

7. Call System Circuits.--Three separate circuits are employed in the call systems. The "passenger call stewardess" circuit consists of an Edwards #620 push button located on cabin wall opposite each seat, an Automatic Electric Relay, a red bull's eye light, and an Edward #260-C push button mounted in a box just forward of the passenger entrance door and below the top longeron. The "co-pilot call stewardess" circuit consists of an Edwards #620 push button located on the support shelf for the instrument board lights, and a second automatic electric relay, Edwards #260-C push button, and a green bull's eye light located in the same box with

Nº	NAME	MANF'R.	NO. USED	PART Nº
1	GENERATOR-DYNAMOTOR ASS'Y.	ECLIPSE	1	M 2719
2	" CONTROL BOX-SPECIAL	"	1	C868 AC2
3	BATTERY ASS'Y.	BAT	1	
4	BOOSTER COIL	ECLIPSE	2	C19543
5	AMMETER ASS'Y.	WESTON	1	506 SPEC.
6	SWITCH ASS'Y.-SOLENOID	ECLIPSE	2	0165484
7	SOLENOID-STARTER MESHING	"	2	0168766
8	STARTER MOTOR	"	2	
9	LANDING GEAR MOTOR	"	1	D-21086
10	" " " SWITCH	REMY	4	404-A
11	MAGNETO	SCINTILLA	4	VAG 9A
12	THERMOCOUPLE ELEMENT	WESTON	6	
13	" LEAD L. ENGINE	"	3	
14	" " R. ENGINE	"	3	
15	" SWITCH SPECIAL	DELCO	1	21-1352
16	" INDICATOR	WESTON	1	602
17	KLAXON-12V	KLAXON	1	
18	TACHOMETER GENERATOR-TYPE 2	WESTON	2	544
19	" INDICATOR -0-2500	"	2	545
20	SWITCH ASS'Y.-LANDING LIGHT	HUBBELL	2	8051
21	" " DOME LIGHT	C-H	2	8210
22	" " RUNNING LIGHT	HUBBELL	4	8051
23	" " INSTRUMENT LIGHT	HUBBELL	3	8051
24	" " IGNITION	DELCO	1	AS 1252
25	" " LANDING WARN.-ON GEAR	GRAYBAR	2	5004
26	" " " " -ON THROTTLE	"	2	5004 SPEC.
27	" " STARTER		2	31-1472
28	" " COURTESY LIGHT	HUBBELL	1	8051
29				
30	" " BATTERY CUT OUT	WECO	1	B-705-A
31	" " PUSH BUTTON	EDWARDS	2	260
32	" " DYNAMOTOR SOLENOID	ECLIPSE	1	M 2658A
33	FUSE-1 AMP		2	BAC-776-3-1
34				
35	CLAROSTAT-INSTRUMENT LIGHTS-20 WATT	CLAROSTAT	3	TYPE C5
36	FUSE PANEL	B.A.C.	1	3-5554
37	CONDENSER-50 MFD-20V	AEROVOX	1	TYPE E25-50
38	" -1 MFD-200V	"	1	" 207
39	LIGHT ASS'Y.-RUNNING-RED	PYLE NAT	2	6-2861
40	" " " -WHITE		1	
41	" " " -GREEN	PYLE NAT	2	6-2861-1
42	" " -LANDING	" "	2	
43	RESISTANCE-SHUNT	ECLIPSE	1	
44	LIGHT ASS'Y.-CABIN WALL-6 C.P.		11	3-4947
45	" " " DOME-15 C.P.		2	3-4948
46	" " -TOILET		1	3-4947
47	" " -MAIL COMP'T.	TOWLES	2	Nº 46½
48	" " -LANDING GEAR WARNING-RED	B.A.C.	2	21-922
49	" " -COMPASS	PIONEER	1	SPECIAL
50	" " -INSTRUMENT	B.A.C.	4	21-1762

Nº	NAME	MANF'R.	NO. USED	PART Nº
51	LIGHT ASS'Y. COURTESY		2	
52	" " RADIO COMP'T.		1	BAC 813-1
53	HEATER-PITOT TUBE-TYPE 357	PIONEER	1	21-1596
54	SWITCH ASS'Y. PITOT TUBE HEATER	HUBBELL	1	8051
55				
56	FUSE-5 AMP	BUSS	6	BAC 776-4-5
57	FUSE-30 AMP	"	4	BAC 776-4-30
58	SWITCH ASS'Y.-CABIN LIGHTS	HUBBELL	1	8051
59	BOX ASS'Y.-JUNCTION	B.A.C.	1	21-1754
60	SWITCH ASS'Y.-RADIO CONTROL	ECLIPSE	1	M 2836
61	CONNECTOR PANEL	B.A.C.	2	PANEL 21-943 BOX 3-4986
62	" "	"	1	PANEL 3-4969 BOX 6-2738
63	" "	"	1	PANEL 3-5071 BOX 3-5070
64	" "	"	1	PANEL 21-1918 BOX 3-5197-1
65	" "	"	2	PANEL 21-1658 BOX 3-5197-5
66	" "	"	1	PANEL 3-4974 BOX 3-4973
67	" "	"	1	PANEL 3-5074 BOX 6-2985
68	" "	"	1	3-4989
69	" "	"	1	3-4981
70	" "	"	1	PANEL 21-1918 BOX 6-2363
71	" "	"	1	PANEL 6-2725 BOX 6-2726
72	BOOSTER COIL SWITCH	ECLIPSE	2	B22913
73	CONNECTOR PANEL	B.A.C.	1	PANEL 21-1653 BOX 3-5188
74	PLUG	W.A.	1	E 376
75	SWITCH ASS'Y.-FUEL PRESSURE WARNING	PIONEER	2	760-0
76	LIGHT " " " "	B.A.C.	1	21-922-1
77	CONNECTOR PANEL	B.A.C.	1	3-5197-3
78	SWITCH ASS'Y.-WARNING SIGN	H.A.DOUG	1	5128
79	WARNING SIGN	B.A.C.	1	6-2961
80	FUSE 10 AMP	BUSS	1	BAC 776-4-10
81	CONNECTOR PANEL	B.A.C.	1	PANEL 21-1918 BOX 3-5197-2
82	" "	B.A.C.	1	3-5197-4
83	SWITCH	H & H	2	W119
84	JACK	WECO	1	215A
85				
86				
87	PUSH BUTTON	EDWARD	13	Nº 620
88	ANNUNCIETTE DROP	"	1	
89	LIGHT-GREEN PILOT CALL	B.A.C.	1	
90	" -RED PASSENGER CALL	B.A.C.	1	
91	PUSH BUTTON LIGHT CUT OUT	EDWARD	1	260-C
92	RELAY	AUTOMATIC	2	D 280574
93	PLUG ASS'Y. RADIO	B.A.C.	1	6-3234
94	PANEL ASS'Y.	B.A.C.	1	21-2582

WIRE Nº	SIZE	LENGTH	WIRE Nº	SIZE	LENGTH	WIRE Nº	SIZE	LENGTH	WIRE Nº	SIZE	LENGTH	WIRE Nº	SIZE	LENGTH	WIRE Nº	SIZE	LENGTH	WIRE Nº	SIZE	LENGTH	WIRE Nº	SIZE	LENGTH	WIRE Nº	SIZE	LENGTH
1	T.L.	123"	34	2	96"	67	18	130"	100	16	105"	133	2	——	166	18	36"	199	18	50"	232	18	180"			
2	T.L.	88	35	2	122	68	18	86	101	T.L.	126	134	16	24"	167	18	21	200	18	50	233					
3	T.L.	101	36	4	57	69	18	43	102	T.L.	125	135	16	82	168	16	74	201	16	28	234	20	360			
4	T.L.	123	37	10	156	70	18	132	103	T.L.	108	136	2	——	169	18	96	202	14	294	235	20	216			
5	T.L.	88	38	10	128	71	16	240	104	T.L.	126	137	10	162	170	10	66	203	16	17	236	18	324			
6	T.L.	101	39	10	46	72	18	264	105	T.L.	125	138	10	84	171			204	14	294	237	18	210			
7	T.L.	122	40	10	90	73	10	——	106	T.L.	108	139	10	44	172	10	66	205	18	50	238	18	94			
8	T.L.	88	41	16	126	74	10	60	107	T.L.	125	140	10	90	173	18	30	206	18	50	239	16	67			
9	T.L.	102	42	16	131	75	18	36	108	T.L.	125	141	18	120	174	16	216	207	18	96	240	18	48			
10	T.L.	122	43	16	36	76	18	110	109	T.L.	109	142	16	86	175	14	36	208	18	96	241	18	19			
11	T.L.	88	44	14	120	77	18	88	110	T.L.	125	143	16	26	176	10		209	18	66	242	18	44			
12	T.L.	102	45	14	126	78	20	90	111	T.L.	125	144	18	123	177	14	36	210	6	66	243	18	45			
13	T.L.	121	46	14	44	79	18	36	112	T.L.	109	145	14	85	178	16	74	211	10	41	244	2	9			
14	T.L.	88	47	10	17	80	18	36	113	T.L.	124	146	14	43	179	18	132	212	6	69	245	2	25			
15	T.L.	103	48	6	67	81	20	108	114	T.L.	125	147	10	17	180	18	121	213	6	68	246	18	132			
16	T.L.	121	49	18	120	82	18	33	115	T.L.	111	148	16	123	181	18	155	214	4	8	247	16H.T.*	72			
17	T.L.	88	50	18	124	83	20	72	116	T.L.	124	149	16	264	182	18	80	215	4	19	248	16H.T.*	72			
18	T.L.	103	51	2	32	84	18	90	117	T.L.	125	150	18	100	183	18	324	216	16	26	249					
19	18	132"	52	16	42	85	18	24	118	T.L.	111	151	18	210	184	18	108	217	2	——	250	18	60			
20	18	121	53	16	42	86	20	56	119	18	132	152	16	102	185	18	71	218			251	18	60			
21	18	110	54	H.T.	ENG.	87	18	132	120	18	80	153	16	126	186	2	——	219			252					
22	18	140	55	16	68	88	20	72	121	18	108	154	16	264	187	16	41	220			253	10	——			
23	18	98	56	18	88	89	20	96	122	18	140	155	16	324	188	2	48	221			254	16	90			
24	18	ENG.	57	12	252	90			123	18	137	156			189	2	27	222			255	16	131			
25	18	140	58	12	125	91			124	18	ENG.	157	H.T.	ENG.	190	2	27	223			256	16	36			
26	18	98	59	12	63	92	16	85	125	18	140	158	18	132	191	2	29	224			257	16	90			
27	18	ENG.	60	16	432	93	16	12	126	18	137	159	18	96	192	18	20	225			258	16	30			
28	10	——	61	18	396	94	18	96	127	18	ENG.	160	18	96	193	18	132	226			259	20	66			
29	10	——	62	2	——	95			128	10	——	161	16	96	194	10	37	227			260	20	66			
30	10	——	63	18	36	96			129	10	——	162	18	96	195			228			261					
31	16	150	64	18	252	97			130	10	——	163	18	96	196			229			262					
32	16	124	65	18	124	98	16	84	131	16	——	164	16	76	197			230			263					
33	16	110	66	18	45	99	16	105	132	16	——	165	18	264	198			231	18	180	264					

NO.	CHANGED	C.O. No.	FROM
H	5-8-33	18903	ADDED
G	5-8-33	18903	TRACED

SCALE ——
ALL DIMENSIONS IN INCHES.
DECIMAL DIMENSIONS WITHIN ±
FRACTIONAL " " ±
UNLESS OTHERWISE NOTED
MATERIAL ——
TREATMENT ——
FINISH ——
APPROVED (N.A.) (ARMY) DATE

DRAWN	CARLSEN	3-8-33
TRACED	PLUYLAAR	5-8-33
CHECKED	Carlsen	5-11-33
STRESS CK.	——	——
WEIGHT CK.	——	——
SHOP CK.		
APPROVED	Harding	5-11-33
APPROVED		

16

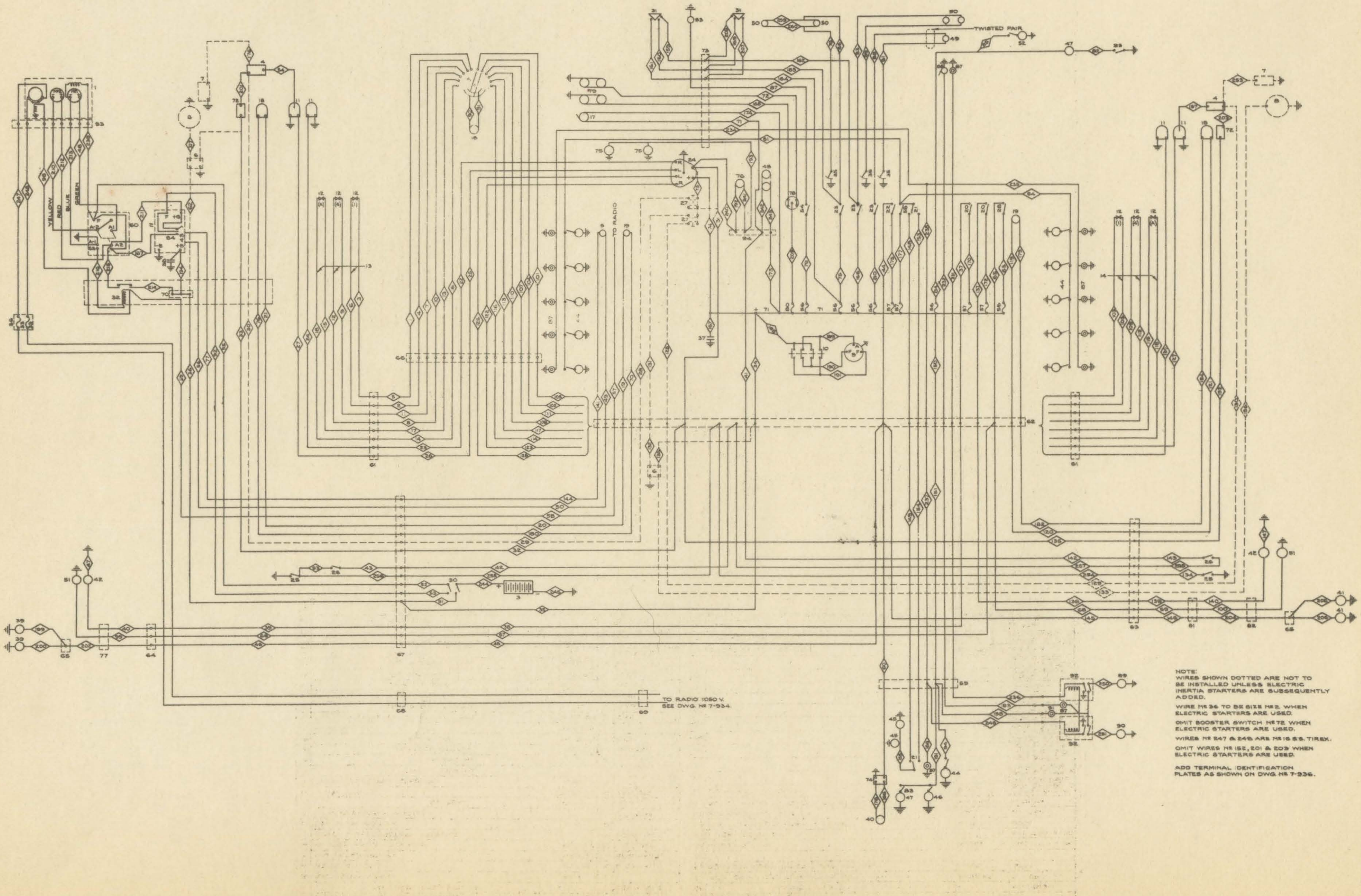
DIAGRAM
WIRING-MODEL 247

ISSUE DATE OF PRINT | ISSUE NO.

BOEING AIRPLANE COMPANY
SEATTLE WASHINGTON

14-800

247
15-2516



NOTE:
WIRES SHOWN DOTTED ARE NOT TO BE INSTALLED UNLESS ELECTRIC INERTIA STARTERS ARE SUBSEQUENTLY ADDED.

WIRE Nº 36 TO BE SIZE Nº 2 WHEN ELECTRIC STARTERS ARE USED.

OMIT BOOSTER SWITCH Nº 72 WHEN ELECTRIC STARTERS ARE USED.

WIRES Nº 247 & 248 ARE Nº 16 S.S. TIREX.

OMIT WIRES Nº 152, 201 & 203 WHEN ELECTRIC STARTERS ARE USED.

ADD TERMINAL IDENTIFICATION PLATES AS SHOWN ON DWG. Nº 7-936.

the "passenger call stewardess" equipment. The above circuits function alike; viz. depressing the button opposite any passenger seat energizes the relay in the circuit. This relay operates two sets of contacts; one set causes the red bull's eye light to go ON, the other completes a circuit through the relay coil to the Edwards #260-C button to ground. (This latter button is normally closed--depress to open). This arrangement causes the relay to hold and the light to remain ON until the 260-C button is depressed. Depressing the Edwards #620 button in the pilot's cabin causes the green bull's eye light to come on and remain on until the second #260-C button is depressed. The "stewardess call co-pilot" circuit consists of an Edwards #620 button located in the box adjacent to the two #260-C buttons and an annunciator located on the support shelf in pilot's cabin. Depressing the button causes the annunciator to operate, warning the co-pilot that his presence is desired in the passenger cabin. No difficulty should be encountered in tracing these circuits on Dwg. #14-800.

8. Cabin Warning Sign Circuit.--The equipment employed in this circuit consists of one H. A. Douglas Co. #5128 four-position switch, located on sub-instrument panel in pilot's control stand, and four 15 c.p. bulbs installed in a container located on left side of front cabin wall. A hinged cover installed on the back of the box--viewed from the passenger cabin--provides access to the bulbs for replacement. This cover is held shut by one machine screw and nut plate. A partition is riveted to the inside of the cover which divides the box into two sections. Two lights used in each section illuminate the top and bottom sign. The four-way switch controls the lights for each or both signs. The wiring is plainly shown on Dwg. #14-800.

9. Cabin Light Circuits.--Two separate circuits, controlled by a master switch located on pilot's instrument board, are employed for the two cabin dome lights and the ten reading lights. This master switch permits the pilot to turn off all cabin lights except stewardess and lavatory light. This to eliminate glare on the wing in foggy weather. This switch, designated "Cabin Lights", should normally be left in the ON position to permit separate operation of the seat and dome lights. In addition to the master switch, a three-way switch, designated "Dome Lights", is installed on the right side of the main instrument board for controlling the dome lights only. A second three-way switch for the dome lights is installed on the toilet wall opposite the entrance door. Employment of these three-way switches permits turning the dome lights ON or OFF at the rear door or in cockpit. Individual switches are provided at each seat light.

10. Landing, Navigation, and Courtesy Light Circuits.--Three switches are employed to control these circuits. The two "Landing Light" switches are located on lower left corner of sub-instrument panel--one for the left and one for the right hand light. One switch, designated "Nav. Lts.", located on the right side of main instrument board controls the navigation light circuit. This circuit includes both of the red and green wing tip lights and the clear tail light. One switch, designated "Courtesy Lights", controls the circuit of the red and green globes installed in the landing light compartment. These lights should be turned on when approaching a landing field or an on-coming airplane. On account of the globes being installed directly ahead of the landing light reflectors they are visible for many miles dead ahead.

11. Engine and Navigation Instrument Light Circuits.--One switch, designated "Nav. Insts.", located on right side of main instrument board, controls the circuit of the two lights located in the center of the shelf across the cockpit just below the front windows. A specially designed hood is used over each of the globes to direct light on the center portion of the instrument board on which are located the flight instruments. The hoods in which the globes and sockets are mounted are fastened to the shelf by means of spring clips. This to facilitate replacement of a defective globe. The brilliancy of these lights is controlled by a clarostat located on the left side of the sub-instrument panel. Two current supplies are provided for the lights--one through the switch referred to above, the other through the push buttons installed in the outboard horn of the pilot and co-pilot's control wheel. Even though the switch on the instrument board is in the OFF position, the lights may be flashed on by depressing either of the outboard buttons on the wheel and at the desired brilliancy as determined by adjustment of the clarostat. A second switch designated "Eng. Insts.", located on the right side of the instrument board, controls the circuit of two lights identical to the flight instrument lights located one each above and aft of the right and left end of the main board. These latter lights flood each end of the board whereas the former lights flood the center portion. A second clarostat is employed to control the brilliancy of these two lights. The circuit functions the same as the circuit described above.

12. Compass Light Circuit.--The switch designated "Comp.", located on the right end of the instrument board, controls this circuit. A third clarostat located on the left end of the sub panel is employed to control the brilliancy of the compass light.

A special telephone switchboard type globe is used for the compass light, and two spares are provided in a drawer type container inserted in the top of the compass. Twisted conductors are employed for the compass light circuit to minimize interference.

13. Pitot Heater Circuit.--The switch designated "Pitot Heater", on the right side of the main instrument board, is employed to control the circuit of the heating coil in the air speed pitot head. It should be turned ON or OFF as conditions warrant.

14. Thermocouple Leads.--Three duplex copper-constantan conductors are installed between a 10-point selector switch located on the pilot's instrument board and each nacelle. The three leads to each nacelle are attached to thermocouple elements installed on the heads of No. 1 and No. 4 cylinders and to a special element installed in each carburetor intake air duct. The indicating instrument located on the instrument board adjacent to the switch is calibrated to 2 Ohms. external resistance. For this reason, it is absolutely essential that this resistance be maintained for each lead between the element and indicator. To overcome the undesirable feature of using extra long lengths of conductors of 2 Ohms. resistance and forming coils of that portion not needed, leads of 26-foot length are used between the switch and the left nacelle and of 30-foot length between the switch and the right nacelle. To compensate for these special lengths, resistors of proper resistance are employed between the ends of the leads and the switch binding posts. This should be considered when ordering new conductor cable from the manufacturer and/or when replacing a length of conductor. By reference to Dwg. No. 14-800, it will be noted that the leads to the right and the left nacelles are broken at two junction boxes--one at the front spar and one in the fuselage. This to facilitate installation or replacement of a complete lead or a section of a lead. To minimize the possibility of an erroneous reading or damage to the indicator from inductance set up in power and light conductors, the thermocouple leads are installed in separate conduit for their entire length. No other conductors except the magneto ground leads are installed in the thermocouple lead conduit and junction boxes.

15. Switches.--The twelve Cutler-Hammer #8201 single pole, single throw, toggle switches originally specified and installed on airplanes NC-13301 to 13324, inclusive, were found to be unsatisfactory in service. Hubbel #8051 switches were used on NC-13325 and subsequent articles. The twelve switches affected control the following circuits: compass, navigation instruments, engine instruments, navigation, cabin reading, courtesy, and landing lights; pitot heater; and the main Long Wave and Short Wave receiver circuits of the radio system. These are located--seven on the right side of the main instrument board; two on the left side of the sub panel, and three on the radio control panel. The three Cutler-Hammer #8210 three-way switches employed in the cabin dome light and crystal heater circuits were retained.

SECTION VIII

FUEL SYSTEM

1. Description: The fuel system employed on these airplanes consists of an engine driven pump, a bypass-relief assembly, and special air separator located in each engine nacelle; an engine selector cock, tank selector cock, hand pump, relief valve and main line strainer located under passenger cabin floor aft of front wing beam; a single compartment tank of 136 gallons capacity in left wing stub; a two compartment tank of 66.7 and 70 gallons capacity located in the right wing stub; interconnecting piping, shut off cocks, drains, pressure gages, pressure warning elements, fuel quantity gages, engine primer and restriction nipples. The flow of fuel to carburetors is as follows: For starting--with tank selector dial turned to desired position, operation of the hand pump draws fuel thru the standpipe strainer in tank sump thru line shut-off cock, thru G-2 cock, thru C-2 strainer to the inlet side. The fuel is then forced to the carburetor thru the E-2 engine selector cock, thru open passage in the C-3 bypass-relief assembly directly to the carburetor. Excess fuel handled by the hand pump returns to the suction side of the pump thru a B-1 relief valve connected between the outlet and inlet connections. With the engine running--the fuel is drawn thru the flapper valves in the hand pump, thence thru the E-2 selector cock, open passage in the C-3 assembly to inlet connection of engine pump. It is then forced upward to special air separator thence downward to carburetor. Excess fuel handled by the engine pump passes thru relief valve in C-3 assembly, thence to a 45° Tee in the incoming supply line. This type Tee causes a syphon effect between the relief and incoming fuel. Any air separated out of the fuel to carburetor is lead off from the top of the separator thru a metered restriction thence thru a $\frac{1}{4}$" line to the top of the carburetor float chamber.

SPECIAL NOTE: During overhaul or preparation of a carburetor for use on these airplanes, it is necessary to drill and tap the float chamber covers to take a $\frac{1}{4}$" hose nipple via. 1/8 pipe thread. The metered restriction in the top of the separator is necessary to prevent flooding of the carburetors at idling. Lengths of interconnecting piping between pump, separator, bypass-relief assembly and carburetor were held to a minimum to decrease possibility of air locks. The air separators were located in the top nacelles to prevent carburetor flooding if and when the fuel cocks remain "ON" when the engine is not operating.

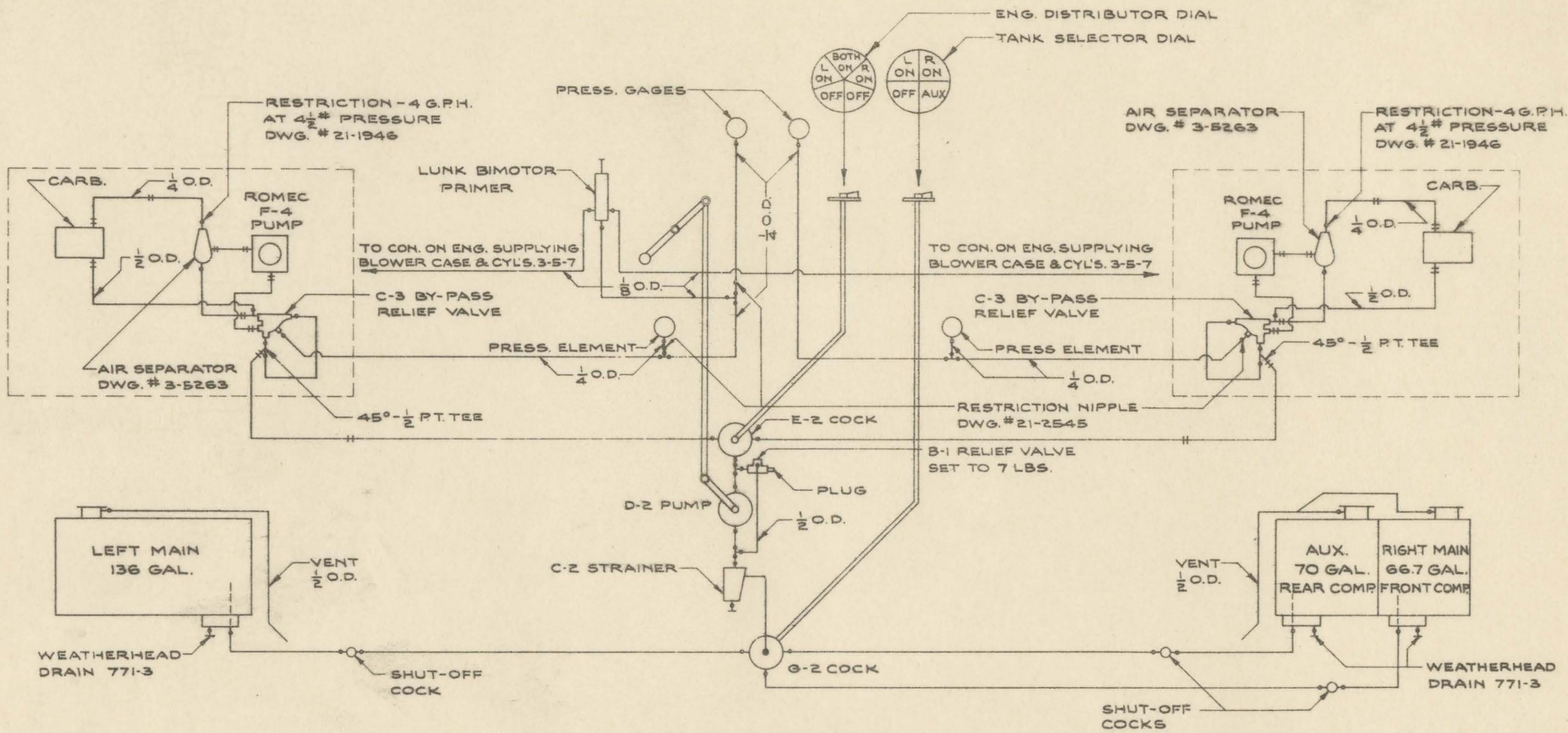
The complete installation is shown diagrammatically by dwg.3-5258 attached. Red bands are painted on all the fuel system piping for identification purposes.

Complete installation details of the system are shown on dwg.15-2574.

2. Engine Driven Pumps: One Romec F-4 pump is installed on each engine. The performance characteristics of the Romec rotary type pump are superior to those of the C-5 gear type. Turning at 2000 RPM the Romec pump delivers 175 gallons per hour against a 10 lb/sq.in. discharge pressure and a 10 foot suction lift. A dry pump is able to prime itself at 250 RPM from a suction lift of 3.5 feet. Primed, it can maintain a pumping capacity of 15 gal./hr. at 200 RPM at a 5 foot suction lift and a 5 foot discharge head. The pump may be run dry for periods of one to two hours without damage. A $\frac{1}{4}$" drain pipe is provided on the pump to lead off any fuel which may escape past the packing gland.

3. Bypass-Relief Valve Assemblies: One N.S.P. type C-3 bypass-relief assembly is installed in each nacelle. A poppet-type stainless steel valve is employed in the relief section of the unit. This type is far superior to the previous ball type. Access to the units for inspection or adjustment may be had by removing the cowl on the left side of each nacelle. The flow of fuel thru, and function of these units, is clearly shown on dwg. 3-5258.

4. Air Separators: A special pear shaped, cast aluminum, air separator is installed near the top cowling on the left side of each nacelle. A baffle set at 45° is cast in the unit between the inlet and outlet connection bosses. Two 5/8" holes in this baffle permit passage of fuel from one side to the other. Fuel from the engine pump flows in thru one side above the baffle. Any air present rises to the top of the unit and escapes thru a metered orifice which is piped to the top of the carburetor float chamber as described above. Fuel flows out of the unit thru the bottom, below the baffle, being piped directly to the inlet connection of C-3 relief assembly. From a Tee in this line, fuel is supplied directly to the carburetor. Excess fuel handled by the engine pump passes thru the relief valve and is piped to a 45° Tee in the main supply line. The restriction nipple installed in the top of the separator is drilled with a #76 drill (.020" hole). For this reason the restrictions should be periodically inspected to see that no dirt or foreign matter has plugged the small passage.



NOTE:
ALL LINES ⅝ O.D. EXCEPT AS NOTED.

CONNECTION DESIGNATIONS:
-•- = SOLID TYPE CONNECTION
-‖- = FLEXIBLE TYPE CONNECTION

STRESS ENGINEER
SHOP LIAISON ENGINEER
WEIGHMASTER

18

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED — LIMITS TO BE WITHIN —— UNLESS OTHERWISE SPECIFIED — PART No. 3-5258

DIAGRAM
247 FUEL SYSTEM

DRAWN BY	PLUYLAAR	4-28-33
TRACED BY	PLUYLAAR	5-20-33
CHECKED BY		
APPROVED BY		
APPROVED BY	Harding	5-22-33
SCALE		

I | 5-22-33 | 19200 | TRACED FROM

BOEING AIRPLANE COMPANY
SEATTLE WASHINGTON

3-5258

247

5. Hand Pump and Relief Valve: One type D-2 hand pump with a remote control to the cockpit is installed in the center of fuselage aft of the front wing spar thru the passenger cabin. A B-1 relief valve is installed adjacent to the hand pump. Short lengths of ½" tubing are used between the relief valve and the inlet and outlet connections of pump. Access to these units may be had by removing aisle flooring in the cabin and/or thru the special hinged cowl door in the bottom of the fuselage. To facilitate removal of the hand pump, it is mounted on a bracket which in turn is secured to the fuselage structure. In removing the hand pump, the pump and bracket should be removed as a unit. The B-1 relief valve should be set to open at 7 lbs. pressure. It functions only when the hand pump is operated.

6. Valves, Strainer and Piping: One each E-2 and G-2 cork seated control cock and C-2 strainer is installed in the center of the fuselage adjacent to the hand pump and B-1 relief valve. The E-2 and G-2 cocks are operated from the pilot's cabin by means of steel tube torque shafts, universals and spur gears. Tee type handles are installed on the sub-panel for turning torque shafts. A Weatherhead drain cock is installed in the bottom cover of the C-3 strainer to permit drainage of any water trapped therein. Access to the above units may be had thru the hinged door under the bottom of the fuselage and by removal of aisle floor section in the passenger cabin.

<u>NOTE</u>: All tubing used in the fuel system--1/8",1/4", 1/2", and 5/8" O.D.--of airplane D.ofC.#13311 and subsequent articles is "Everdur". The fatigue characteristics of this tubing are far superior to copper. Copper tubing was employed in the first ten airplane, D.ofC.Nos.13301 to 13310 inclusive. Overhaul and Repair bases should note dwg.15-2574 to determine types and sizes of various connector fittings employed in the system. Piping insofar as possible is secured to the structure by means of fiber fairleads. Hose connections with liners are employed on each end of each section of tubing between the fuel pump and carburetor and air separator and bypass-relief assembly. This is to protect these lines from engine vibration. Hose connections are also used in the 1/4" line between carburetor and the top of the air separator.

Installed in the main supply line from each tank is a Parker shut-off cock. These cocks are secured to the fuselage structure just above the bottom wing stub skin. The purpose of these cocks is to permit shutting off fuel from the tanks if and when it is necessary to remove or repair the G-2 tank selector cock or lines. Were these cocks not used it would be necessary to completely drain all tanks before removal of the G-2 cock or lines connecting it. These cocks should be normally safetied in the open position.

7. Tanks and Vents: Two cylindrical tanks of elliptical cross section, welded aluminum, are installed, one in the right and one in the left wing stub. Access to these tanks is had by removing the lower wing stub cowling. This cowling is secured to the wing structure by means of 10-32 machine screws inserted in fiber lock nut plates. Hinged doors are provided in the lower surface of wing stubs for routine inspection. Each tank is held in place by means of four cork lined straps and brackets. Turnbuckles are employed to adjust tension of straps. The left tank (dwg.No.15-2432) is a single compartment unit of 136 gallons capacity. The right tank (dwg.No.15-2431) is a two-compartment unit. The front compartment--RIGHT MAIN--is of 66.7 gallons capacity; the rear--AUXILIARY--of 70 gallons capacity. Extra large sumps and filler necks are provided for each of the three tanks--LEFT; RIGHT; AUXILIARY. One-half inch aluminum tubes are used for venting. These vent tubes are welded to 5/8" aluminum tubes which serve as drains for the overflow well around the filler neck. This minimizes the number of tube ends projecting thru lower wing stub cowling. The two vents and well drains on right tank are likewise welded together forming one tube thru the cowling. If and when a tank is removed, extreme care should be used when reinstalling to ascertain that well gaskets at filler necks are tight. This is to insure against fuel spilled around the filler neck from seaping into the tank compartment. Small scoops are provided on under surface of wing stub to provide forced ventilation in the tank compartment. Hinged covers are provided over the filler necks and below sumps. Screen covered standpipes are employed in the sumps to insure against water or dirt entering outlet piping. Weatherhead drain cocks are installed in the sumps to facilitate quick drainage of any water collected.

8. Fuel Level Gages: Kollsman hydrostatic fuel cell assemblies are installed in the left, right, and auxiliary tank. From the outlet connection of the cell in the left tank, a 3/16" copper tube is lead directly to a fuel gage pump on the lower left end of the pilot's instrument board thence to left gage located adjacent to the pump. From the outlet connection of the cell in the right main tank a 3/16" copper tube is lead to the right fuel gage pump on the instrument board, located adjacent to the left pump thence to the right gage. From the outlet connection of the cell in the auxiliary tank a third

3/16" copper tube is lead to and dead ended near the gage pumps. This arrangement will be found in the first 18 airplanes, D. of C. Nos.13301 to 13318 inclusive. On all subsequent articles a special two-way cock is installed on the instrument board to which is connected both of the 3/16" lines from Right and Auxiliary tanks. By switching this cock and operating the right gage pump, it is possible to determine the quantity of fuel in either the Right Main or Auxiliary tank. Cocks will be supplied for installation on airplanes not so equipped.

9. Pressure Gages and Warning Devices: Due to the fact that the fuel supply to the engine primer is obtained from a Tee in the fuel pressure gage line from the left engine, the installation to the left and right gages are not alike. Also the installations made in the first 18 airplanes, D. of C. Nos.13301 to 13318 inclusive, are different from subsequent installations. This difference is slight and consists only of moving the pressure warning devices from the original location in the engine nacelles to the section below the pilot's cabin. As clearly indicated on 3-5258, restriction nipples are employed in the pressure lines ahead of each gage and pressure elements. These nipples are drilled .040" (#60 drill) to guard against loss of excess fuel in case of gage or piping failure.

Extreme care should be used in checking and adjusting the electrical contacts in the pressure elements. The contacts should open when the fuel pressure reaches 2 lbs./sq.in. The warning devices function as follows: when the fuel pressure to either carburetor drops to or below 2 lbs. the contacts in the elements close. This completes an electrical circuit thru a green bull's eye light located between the two gages on the pilot's instrument board. Lighting of this light warns the pilot visibly that the fuel pressure is dangerously low. This warning in many instances allows the pilot sufficient time to switch from one tank to another before the engines cut out or the system begins to fill with air from exhausted tank. The current supply to bull's eye light and contacts passes thru the master ignition switch. This eliminates the necessity of providing a special switch to turn off the light when the engines are not operating.

10. Priming System: This installation consists of a Lunkenheimer two-engine primer assembly installed on the pilot's instrument board and lengths of 1/8" piping to a special Tee on the blower section of the right and left engine. This Tee has four outlets--one each to blower case and cylinders No.3,5,and 7. A special stainless steel core shut-off cock is incorporated in the primer pump assembly to prevent fuel leakage at the packing gland. A second cock is provided in the unit for right or left engine priming. Priming system as well as all other fuel system piping is grouped together and secured to the structure by means of fiber fairleads.

SECTION IX

OIL SYSTEM

1. Description: A separate, individual oil system is installed in the right and left nacelle for each engine. Each consists of a welded aluminum tank of 10 gallons capacity; a United Aircraft Products 6" diameter cartridge core cooler incorporating a spring and manual control bypass valve; a 1" Lunkenheimer "Y" oil drain cock; a special National Steel Products two-way oil cock; interconnecting and pressure piping as shown by Figure 9. The 3/4" vent and 1" main lines are 2 SO aluminum, annealed after bending. The 1/4" pressure lines to cockpit gages are annealed copper. Yellow bands are painted on all oil system piping for identification purposes.

2. Tanks: (Note) These units in the first ten airplanes (Mfg. Nos. 1682 to 1691 incl.) are not interchangeable since they were manufactured as Rights and Lefts. By a slight change in location of coupling flanges it was possible to use the same tank in the right and left nacelle. These tanks, Dwg. No. 9-1307, should be installed if and when replacements are made.

The tanks are secured to the nacelle structure by means of brackets and supporting straps which are lined with cork to prevent damage from chafing. The filler necks are located on the tanks that sufficient expansion space is provided even though the tanks are filled to overflowing.

3. Cooler: This unit is located above and aft of the tank and faired into the top cowling. A shutter assembly, actuated by a cable control from cockpit, is installed in front of the cooler for controlling the amount of air passage through the cooler. As an additional means for controlling engine temperature, a nose shutter assembly is mounted directly in front of each engine. The control cables for these shutters are interconnected with those for the oil cooler shutters. This arrangement provides simultaneous operation of both the nose and cooler shutters on each engine by means of single control levers on the pilot's control stand.

4. Valves and Piping: A 1" Lunkenheimer "Y" oil drain cock is installed in each nacelle directly below the tanks to facilitate quick drainage. A small hinged access door is provided in the cowling directly below these valves. A section

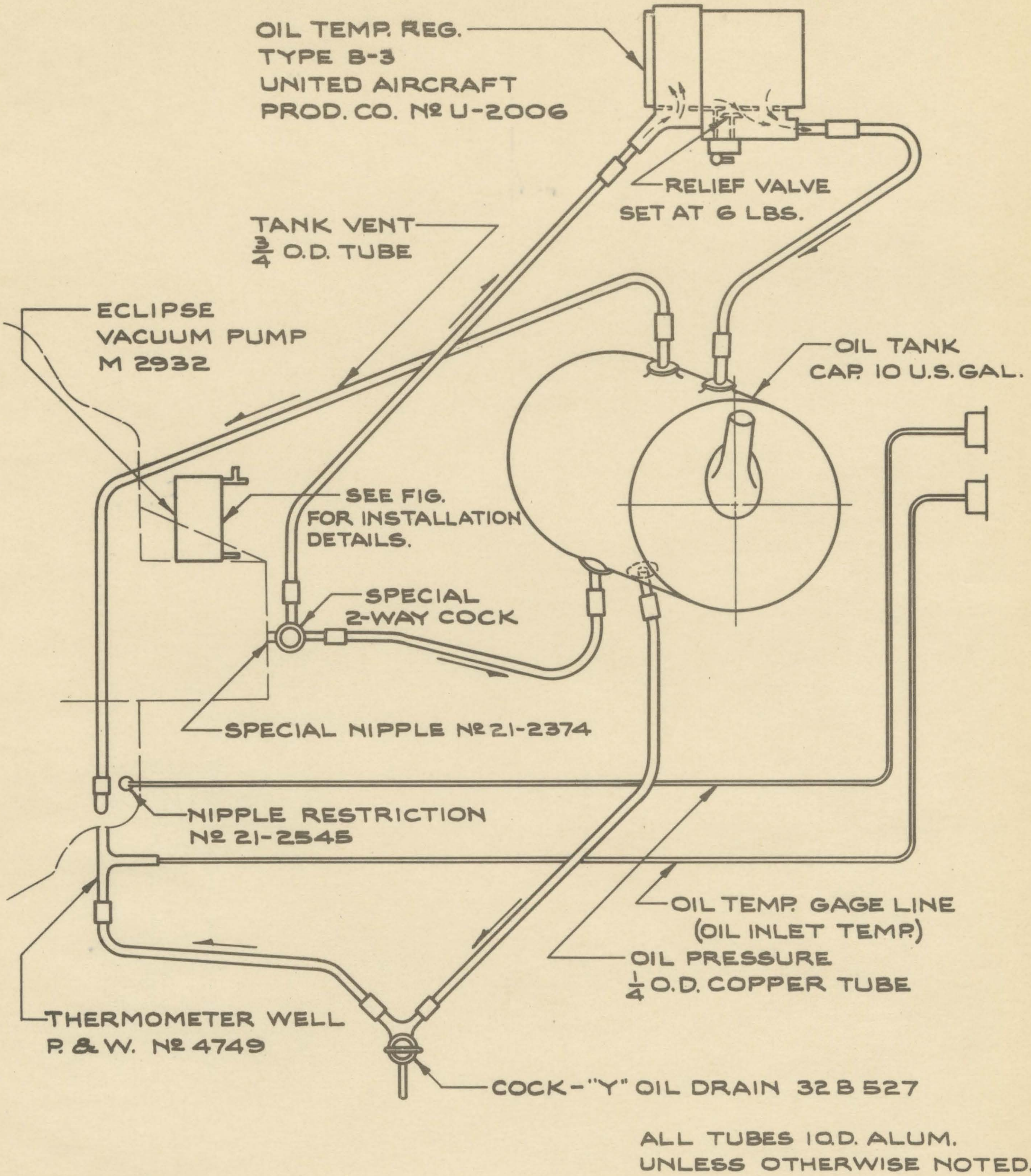


FIG. 9 - OIL SYSTEM DIAGRAM

of the 1" main feed line from the outlet flange on bottom of the tank slopes downward to this valve. A second section slopes upward to the inlet fitting for the engine oil pump. Rubber hose connections are employed to absorb vibration.

A special National Steel Products two-way oil cock is connected by means of a special nipple to the main outlet connection on engine rear case. The purpose of this valve is to provide seasonal control of the return oil to tank. From one connection of the valve a 1" line is installed to a flange fitting on the bottom of the tank adjacent to the main outlet connection. From the other connection of the valve, a 1" line is installed to the inlet connection of the oil cooler. From the cooler outlet fitting a 1" line is installed to a flange fitting on top of the oil tank. By setting the valve for "Cold weather operation", the return oil from engine enters the bottom of tank adjacent to outlet connection. This allows warm oil to be immediately drawn back to engine pump. By setting the valve for "Warm weather operation", the return oil to tank is forced through oil cooler thence to top of tank. The spring loaded bypass valve incorporated in cooler becomes operative if, and when, the flow of oil through cooler tubes is retarded on account of unexpected cold conditions. This valve is set to bypass the oil when the pressure in the line exceeds 6 pounds.

To insure against excessive loss of oil in case of an oil pressure gage or piping failure, a restriction nipple is employed at the pressure connection on engine. This restriction is drilled with a #60 drill (.040" hole).

For complete installation details of oil systems see Dwg. 15-2574.

SECTION X

VACUUM SYSTEM

1. Description: Two separate systems are employed on these airplanes to produce proper vacuum for operating the gyroscopic flight instruments viz., Artificial Horizon, Directional Gyro and Bank and Turn Indicator. The first two instruments require a vacuum of 3" to 4" Hg. This is produced by means of an Eclipse vacuum pump mounted on the left synchronizer drive pad of the right engine. The Bank and Turn Indicator requires a vacuum of approximately 2" Hg. This is obtained from the induction chamber of the left engine. Installation of the indicating instruments is covered in Section XII.

2. Pump: Considerable experimentation was necessary to determine a satisfactory arrangement for disposing of the pump exhaust when installed on the S1D1 engines. The hollow synchronizer drive shafts on these engines are full of oil under pressure which causes a considerable amount to be forced past the hexagon drive of the vacuum pump. Some of this oil was drawn up thru the lower bearing of the pump and discharged thru the exhaust. In some cases the quantity was in excess of a quart per hour. The problem of separating this oil from discharged air was finally overcome by the arrangement shown by Fig. 10. This arrangement functions as follows: The Eclipse M-2932 pump is provided with a top and bottom exhaust port, a felt oil seal below the lower bearing and a special Tee at the intake port. From the bottom exhaust a 3/8" tube is lead to a nipple installed in 1/4" P.T. hole in the side of the rear engine section just below the pump pad. This tube directs the pump discharge into the rear section. The two rear breathers are modified to accomodate connection of a 3/8" tube to each. These leads are joined by a Tee and a third tube installed to a fitting on the carburetor air inlet duct. From one of the leads from one breather, a 1/4" tube is lead to a 1/4" connection of a special Tee provided at the pump intake port. This provides a means of supplying oily air to the pump for lubrication. To decrease the amount of suction at the felt oil-seal, a hole--#60 drill--is drilled thru the pump body connecting the discharge port to the area between the bottom of rotor and felt seal. By directing the exhaust into the rear case, a certain amount of oily air is

forced out of the rear breathers. The modified caps of these breathers direct this oily air to the carburetor intake scoop. The arrangement shown on Fig. 10 was incorporated on airplane D. of C. #13310 and subsequent articles.

3. Relief Valves: For the Directional Gyro and Artificial Horizon--one Eclipse M-2860 relief valve is installed on the bulkhead forward of the pilot's instrument board and directly ahead of the Bank and Turn Indicator. For best operation of the instruments this valve should be set to show a vacuum of 3" to 4" of Hg. Interconnecting piping is shown by Fig. 11. To facilitate attachment of a test gage for adjusting this valve, a test connector is provided on the instrument board to the left of the Bank and Turn Indicator on airplane D. of C. #13319 and subsequent articles. Parts will be supplied to provide this arrangement on airplanes #13301 to 13318 inclusive.

For the Bank and Turn Indicator--a special Kelly Relief Valve is employed in the line from the left engine induction chamber to the Bank and Turn Indicator. This valve is so designed that a vacuum of approximately 2" of Hg. is produced at the instrument regardless of the amount of vacuum formed in the induction chamber. Obviously the amount of vacuum created in the induction chamber between the blower and carburetor is dependent upon the speed of the engine or the throttle position. The Kelly valve automatically compensates for these conditions. It is located ahead of the instrument board on the left side and requires no adjustment. It is adjusted and set at 2 lbs. during manufacture. Care should however be exercised to see that the screen covering over the valve is free of dirt and oil. A test connection for this installation is provided on the board to right of the Bank and Turn Indicator. Installation of this connector is effective on the same airplanes specified above for Artificial Horizon and Directional Gyro. Installation of this equipment is shown by Fig. 11.

4. Piping and Fittings: To conserve weight, vacuum system piping and fittings for the most part are aluminum and dural respectively. A 1/2" O.D. aluminum line is employed between vacuum pump and Eclipse relief valve and a 7/16" O.D. aluminum line between induction chamber and Kelly valve. Vacuum system piping may be identified by green bands painted at intervals around the piping. Short lengths of rubber hose are used between valves, instruments and test connections.

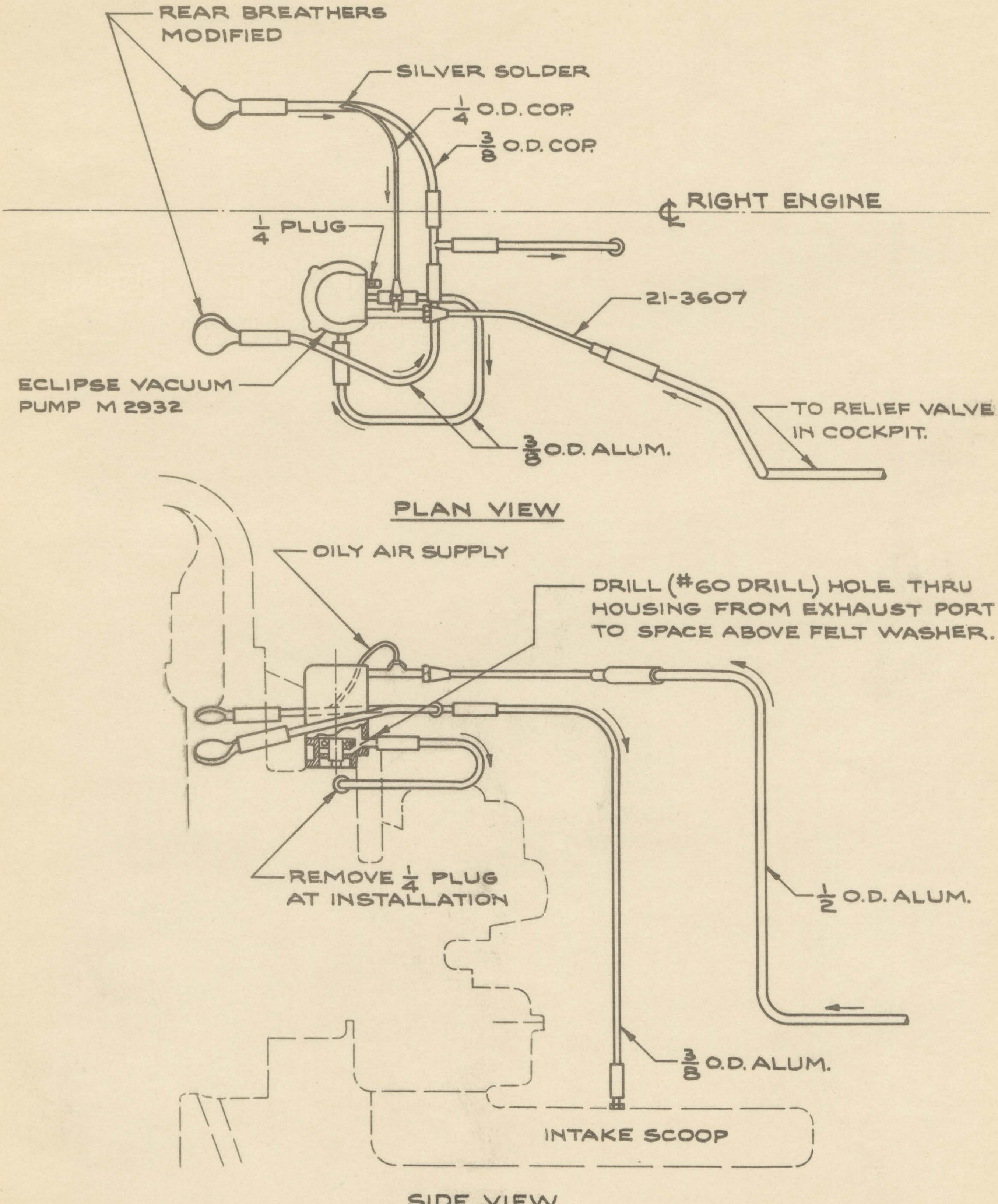


FIG. 10 - VACUUM PUMP & LINES DIAGRAM

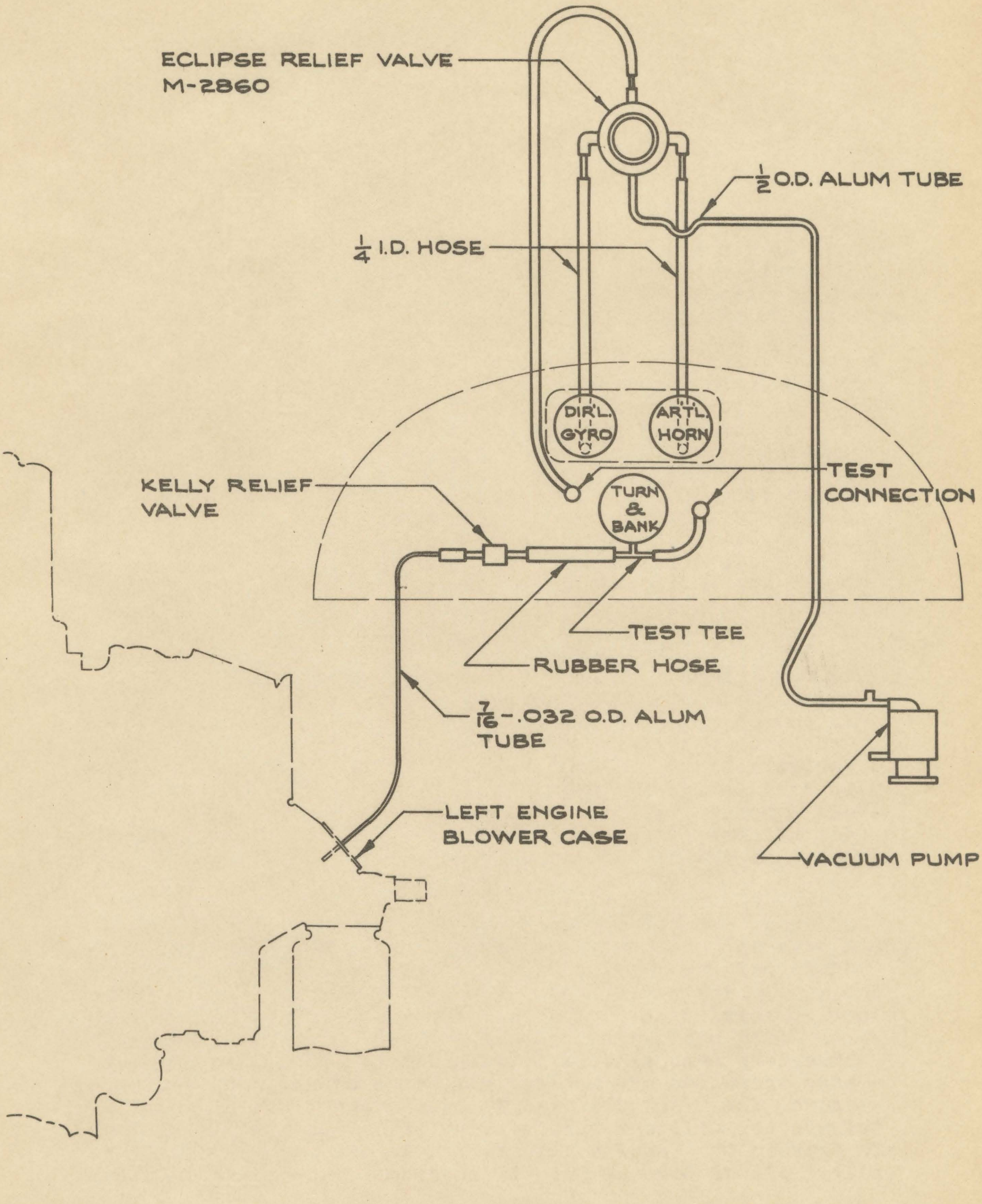


FIG.11-VACUUM SYSTEMS DIAGRAM

SECTION XI

HEATING AND VENTILATING SYSTEM

1. General.- All airplanes after NC-13301 are equipped with manually controlled hot air systems. The air is heated by means of a special tubular stove forming a part of the exhaust tail stack of each engine. The heated air from each stove is conducted through tubes to one side of a three-way valve in each stub, thence into the cabin and cockpit through individual grilles. Cold air is obtained through a scoop in the lower surface of each wing stub and conducted to a second intake on each three-way valve, thence into the cabin through the same ducts and grilles. Hot and cold air intakes are controlled by separate valves, giving several combinations of air flow and temperature. Just above the floor and forward of each passenger seat, are individual grilles with controls which may be regulated by the passenger. Individual grilles are also installed under the pilot and co-pilet seats to conduct air into the cockpit. The master controls for the hot and cold air valves are located on the lavatory partition behind the left rear passenger seat.

2. Hot Air Stoves.- These units are located immediately behind the carburetor air heaters on the outboard side of each nacelle. The outer shell consists of a semi-cylindrical piece of cowling hinged at the top and secured by means of cowl fasteners at the bottom. Tail stack supports, fore and aft of the section comprising the stove, form bulkheads to retain the air forced into the stove through the crescent shaped space between the outer shell and the forward bulkhead. The air outlet is located in the inner cowling at the aft end of the stove.

3. Air Ducts and Grilles.- From the hot air stove the air is conducted through the nacelles and into the wing stubs through polished dural ducts. In the front inboard corner of each fuel tank compartment are the valves for mixing and controlling the hot and cold air flow. The valves and ducts in the system are of riveted dural construction polished to minimize heat loss. A cylindrical duct is used wherever possible, but due to space limitations the collector outlet duct in the forward part of the left fuel tank compartment is rectangular. The valve shells are also rectangular to facilitate the use of rectangular valves. To prevent air leaks in the system, asbestos packing is used at all joints.

Each three-way valve in the hot air line is provided with a by-pass, which is opened when the hot air flow to the cabin is shut off. This permits the air to pass through the stoves and ducts, preventing overheating.

The cold air flow into the system is controlled by the opening or closing of the scoops located in the skin just aft of the three-way valves. The cold air is taken directly into the same ducts that carry the hot air.

4. Controls.- Rods are used to connect the valve levers to the operating levers on the outer ends of two transverse torque shafts that cross the fuselage just below the cabin floor at approximately Stations 20 and 21. Below the left floor panel at this point are located the valve operating springs, the spring attachment fittings and the forward terminals of the operating cables. The springs and cables are fastened to the torque shaft levers in such a way that the spring action tends to keep the cold air scoops open, and the hot air valves closed. The control cables pass under the floor support at the rear spar and continue aft to pulleys at the lavatory partition over which they pass and up through the floor to the turnbuckles on the control levers.

Adjustment of the valve control system is made in the push rods (one end of each being adjustable), the turnbuckles mentioned above, and the rods that operate the air scoops in the lower wing stub skin.

The moving parts and various bushings in the system should be periodically lubricated with a mixture of one pint of Mobile "E" plus one teaspoon of "Pyroil". Installation of the heating and ventilation system equipment are shown on Dwgs. 15-2669 and 15-2910.

At the time of compilation of this manual an entirely different heating system from that described above is under development. It is expected that the new liquid, electrically controlled system will be ready for installation in the Model 247 airplanes by the fall of this year. When sufficient tests have been completed to warrant adoption of the liquid system, the necessary parts, together with detailed installation instructions, will be supplied for all delivered airplanes. This Section of the manual will also be rewritten to cover the new system.

SECTION XII

INSTRUMENTS

1. Main and Sub-panels:- Four separate panels are provided for the instruments and switches as shown on Fig. 13. The main board is fabricated from .064 SO heat treated to 17 ST dural. It is mounted on four 20 lb. capacity Lord shock proof units. A separate individually shock-proofed panel is mounted on the main board for the Artificial Horizon and Directional Gyro. Four 6 lb. capacity Lord units are used to obtain additional shockproofing for these two instruments. This sub-panel may be easily removed as a unit by removal of the four machine screws--two at each end--used to attach the panel to the shock proofed brackets. A third panel is mounted on top of the pilot's control stand. A section of this panel is hinged to facilitate quick inspection or replacement of radio control switches, etc. The units installed on this hinged section are described in detail in Section XIII. Shielding covers on the main and sub-panels are secured by means of machine screws and nut plates. Nut plates are also provided for the warning light jeweled glass cover screws.

2. Artificial Horizon and Direction Gyro: As previously stated, one each Sperry Artificial Horizon and Directional Gyro is mounted on the separately shock proofed sub-panel in the upper center of the main board. Extreme care must be used when mounting the Artificial Horizon to insure that the surface of the panel is perfectly flat. If the panel is at all warped it is quite likely that the mounting lugs may distort the case when the mounting screws are tightened. Lengths of 3/16" I.D. red rubber hose are used between the instruments, the manometer connection, and the Eclipse relief valve. See Section X for installation details of the vacuum pump, piping and valve.

3. Airspeed Indicator:- One Kollsman Type 17 airspeed indicator is installed on the main board below and slightly to the left of the Directional Gyro. As previously stated in Section VII, Paragraph 11, the instruments grouped together in the center of the main board are Flight Instruments, viz. Artificial Horizon; Directional Gyro; Air Speed, Bank and Turn, Rate of Climb Indicators; Altimeter; Manifold Pressure Gage; Clock. The method of mounting the airspeed indicator differs from that of the other instruments. By removing the conventional lugs from the case and providing clamping plates for the mounting screws it is possible to rotate and clamp the

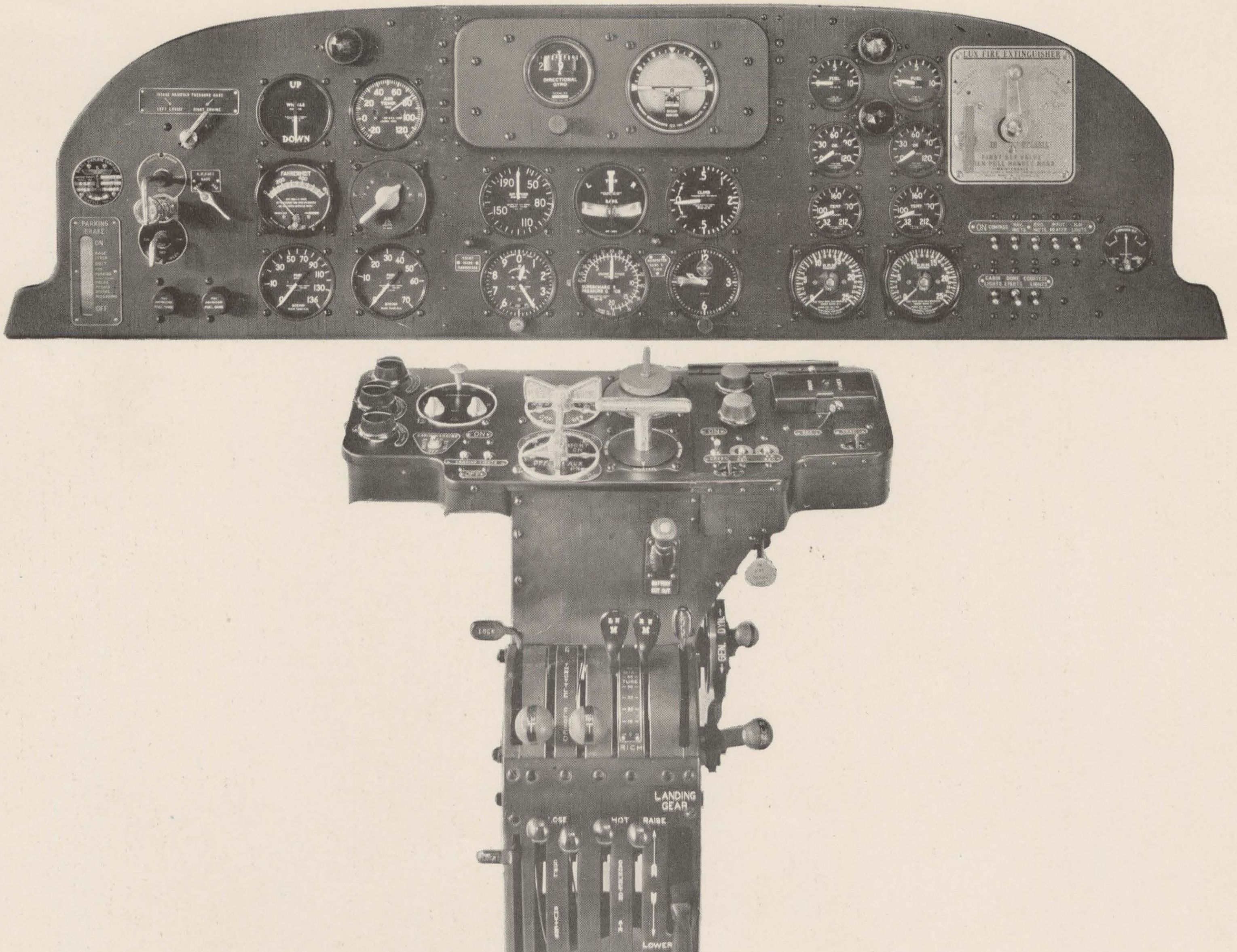


FIG. 14—INSTRUMENT BOARDS AND CONTROL STAND

instrument with the pointer in any desired position. This arrangement permits determination of the desired cruising speed and placing the pointer horizontal at this speed. To alter this position it is only necessary to loosen the four mounting screws, rotate the case the desired amount and tighten the screws. One-quarter inch O.D. aluminum tubing is employed between the indicator and a Pioneer Type 357-C pitot tube installed on a streamlined bracket below the nose mail pit. An electrically operated heating element is provided in the pitot assembly. See Section VII, Paragraph 13, for wiring details of the heater coil.

4. Bank and Turn Indicator:- This unit is a Pioneer Type 385. It is flush mounted adjacent to the air speed indicator. Vacuum for operating its gyro is obtained from the induction chamber of the left engine. See Section X for installation details of this equipment. Immediately to the right of this instrument a manometer test connection is provided.

5. Rate of Climb Indicator:- This unit is a Pioneer Type 374. It is flush mounted adjacent to and in the same plane with the air speed and Bank and Turn. The thermally insulated tank used in connection with this instrument is installed on the bulkhead forward of the instrument board. A length of 1/8" O.D. copper tubing is installed between the tank and instrument. Care should be used to insure against leaks developing in the piping or fittings.

6. Altimeter:- This unit is a Kollsman Type 31-A. It is flush mounted directly below the Air Speed Indicator.

7. Manifold Pressure Gage:- On Airplanes No. NC 13301 and 13302 special Pioneer type 772-2 gages were installed. On subsequent airplanes up to and including approximately 13331 standard Pioneer type 737 gages were installed. The special 772-2 gages differ from the 737 in that the former are equipped with a key reset tell-tale pointer in addition to the indicating pointer. A sufficient quantity of the 772-2 gages are on order to replace the type 737 gages. As soon as the new type are available they will be procured and supplied for installation. Instructions for dispostion of the type 737 gages will also be issued. See Section II for operation and function of the manifold pressure gage.

To eliminate the necessity of employing a separate gage for each engine a special cock is employed for changing from one engine to the other. This cock is located near the upper left corner of the main board. The name plate provided above the cock clearly indicates the position of the control handle for obtaining the manifold pressure of the right or left engine. The cock is designed in such a way that no "dead spot" or "off" condition exists. The handle should be thrown to the full right or left position to obtain a correct reading. The above arrangement was deemed satisfactory since when the engines are turning at the same RPM the manifold pressures will be the same.

8. Clock: This unit is flush mounted adjacent to and directly below the Rate of Climb Indicator. It is a standard Waltham aircraft clock. A small knob projects thru the board for winding and setting.

9. Magnetic Compass: This unit is mounted on a bracket located in the "V" formed by the two front windshield glasses. It is a Pioneer type 744. Lighting of the card for night operation is accomplished by a telephone switchboard bulb, installed in a drawer type container in the top of the assembly. Clips for two spare bulbs are provided in the drawer. See Section VII, 12 for wiring details.

10. Tachometers: Two Weston Electric type 545 indicators--one for each engine--are mounted thru the face of the main board to the right of the clock. Nut plates are provided for the mounting screws to facilitate removal. Steel shielding covers employed over the cases of these instruments greatly impairs access to the conventional mounting screw nuts. Weston Type 544 Tachometer generators are installed on each engine to operate the 545 indicators.

11. Outside Air Temperature Indicator: This unit is flush mounted on the main board to the left of the Directional Gyro. A braid covered capillary tube is provided between the indicator and a special coil type bulb installed directly ahead of the "V" formed by the front windshield glasses. The assembly is a model CA, with four-foot lead, manufactured by the Boyce Motometer Co.

12. Fuel Level Gages: These units--one for right tank and one for left tank--are flush mounted on the main board to the left of the Altimeter. They are the hydrostatic type manufactured by the Kollsman Instrument Co. See Section VIII, paragraph 8, for operation of the gage pumps and special cock employed in the lines from the right tank to the right gage. By means of the right gage and right pump it is possible to measure the quantity of fuel in the right main or the auxiliary tank.

13. Thermocouple Indicator and Switch:- These two units are mounted thru the face of the main board directly above the fuel level gages. Nut plates are provided on the back of the board for the mounting screws. The indicator is the Weston Model 602 and the switch is a special Delco 10 point assembly. Only six of the ten contacts on the switch are used--three for the leads to thermocouple elements--one installed on cylinders #1 and #4 of each engine and one in the air intake duct to the right and left carburetor. The four center contacts may be used if and when it is desired to obtain additional temperature readings. See Section X, paragraph 14 for installation details of the thermocouple leads and resistors.

14. Oil Temperature Indicators:- These units--one for each engine--are flush mounted on the main board directly above the tachometer indicator. These are Pioneer Type 506 units with 25 foot, 1/10" O.D., solid leads between the indicators and bulbs. The indicators are calibrated in Fahrenheit. Extreme care should be used when servicing or installing these assemblies to insure against crushing or causing sharp bends in the tubes. A special thermometer well (See Fig. 9, Section IX) is provided at the oil inlet connection on each engine for the bulbs. During replacement of a defective assembly the bonding jumpers should be removed from the tube before it is removed. These jumpers are spot soldered to the tubing at intervals of approximately 36 inches.

15. Oil Pressure Gages:- These units--one for each engine--are flush mounted on the main board directly above the oil temperature gages. They are Pioneer Type 505 units, 0-120 lbs. 1/4" O.D. copper tubing is employed between the gages and special restriction nipples installed on each engine at the oil pressure connection. The restriction nipples are provided to minimize the amount of oil loss in case of a piping or Bourdon tube failure. This should be borne in mind when starting an engine in extremely cold weather. The pressure may take quite a time to come up to normal.

16. Fuel Pressure Gages:- These units--one for each engine are flush mounted on the main board directly above the oil pressure gages. They are the Pioneer Type 505 units, 0-10 lbs. 1/4" O.D. Everdur tubing is employed between the gages and fuel pressure connections on the bypass-relief assemblies in each nacelle. Fuel pressure warning devices and restriction nipples are installed in the pressure lines as explained in Section VIII and shown on diagram 3-5258.

17. Ammeter:- This unit is flush mounted near the extreme right end of the main board. It is a special Weston Model 506 instrument calibrated to show "Charge" or "Discharge" only. It is in reality a millivoltmeter since it is employed in connection with a shunt installed in the generator control box mounting base. See Section VII for wiring details.

18. Landing Gear Position Indicator:- This unit is flush mounted on the main board directly above the thermocouple indicator. It is similar to the Pioneer Type 561-0 instrument except the drive shaft requires $312\frac{1}{2}$ turns to move the pointer from the full UP to DOWN position. A 6'-4" conventional tachometer drive shaft is employed between the indicator and a connection provided on the retracting gear drive mechanism located under the pilot's cabin floor.

19. Engine Primer:- This unit is mounted thru the main board near the left end. It is a Lunkenheimer D-1897 bimotor assembly equipped with stainless steel valve cores. The stainless steel cores greatly reduce the possibilities of leakage.

20. Fire Extinguisher Control:- This assembly, installed thru the main board near the right end, consists of the selector valve control and a Tee handle for operating the safety disc cutter device installed on the CO_2 bottle. The control assembly is attached to the board by means of 4 machine screws and nuts and may be removed from the board as a unit. Installation and operation of the system is covered in Section II, paragraph 9.

21. Ignition Switch:- This unit, mounted on the subpanel on top of the control stand is a bimotor Delco assembly. Two levers are provided on the assembly--one for the Right and Left magnetos of each engine. In addition a master push-pull button is provided for grounding all four magnetos simultaneously. This master button controls two separate sets of contacts in the assembly. When pulled, the four magneto primary leads are grounded and the electrical circuit for the fuel pressure warning lights and booster coils is broken. For this reason the master switch button should be in the PULLED position at all times except when one or both engines are operating.

22. Switches and Clarostats:- The installation and function of these units is covered in Sections VII and XIII. Metal covers with Micarta lining are secured by means of machine screws and nut plates to the back of the main and subpanel. These covers protect and shield the terminals of these units.

All items of equipment referred to in this Section are shown on Dwgs. 9-1403 and 15-2438.

SECTION XIII

RADIO TELEPHONE SYSTEM

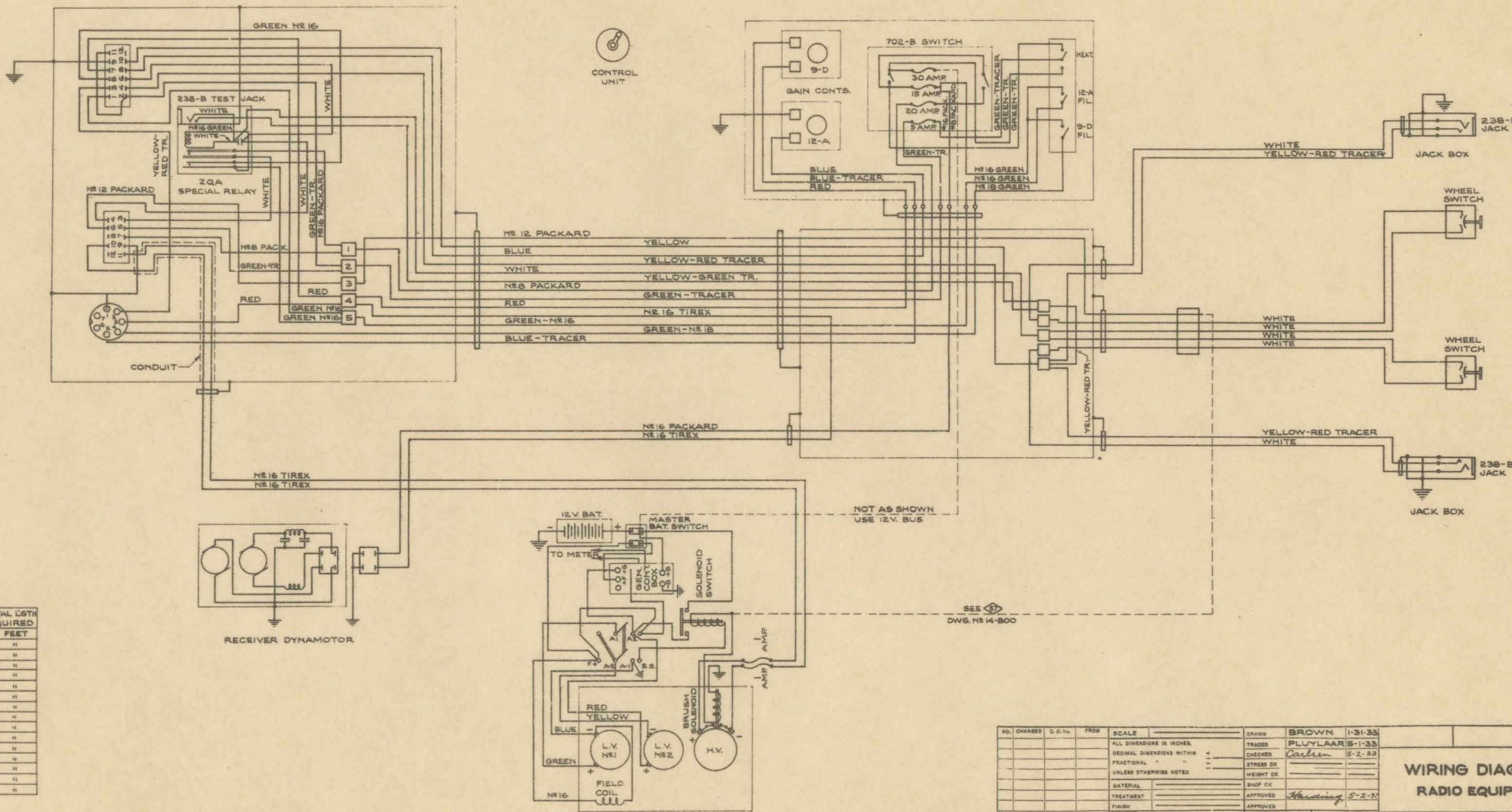
1. Dynamotor-Generator - Transmitting.- The operation of this machine as a low voltage generator is covered in Section VII. As will be seen on Dwg. No. 7-934, attached, there are two low-voltage windings and commutators. By means of an Eclipse M-2836 "change-over" switch these windings function, in series, as a generator, and in parallel, as a motor. The current supply for operation as a motor is controlled by an Eclipse M-2658A solenoid switch. The current generated by the low voltage windings for charging the battery and operating the electrical equipment is controlled by the generator control box. The current for energizing the solenoid switch is controlled by a set of contacts operated by a relay employed in the radio circuit. The change-over and solenoid switches are located on the forward side of the firewall in the left nacelle inboard of the control box. A 1/16" cable control is employed between the "change-over" switch in the nacelle and the control knob located on the right side of the control stand in pilot's cockpit. The position of the "change-over" switch is indicated by the words "GEN." and "DYN." milled in the outer edge of the knob. As outlined in Section VII, the armature drive clutch is disengaged at all engine speeds below 1100 RPM, therefore it is necessary to throw the "change-over" switch to the "DYN." position for transmitting when the engine is not running. The dynamotor-generator will not function as a battery driven dynamotor when the "change-over" switch is in the "GEN." position. Care should be exercised to insure that the "change-over" switch is in the "GEN." position at all times <u>except</u> when it is desired to transmit with the engine idling slowly or off. The switch should not be in the "DYN." position during take-off or in flight.

As will be further noted on Dwg. No. 7-934, a high voltage winding is incorporated in the machine for supplying plate current to the radio transmitter. The brushes for the high voltage supply are normally held out of contact with the high voltage commutator. A special solenoid mounted on the side of the machine is employed to depress these brushes <u>only</u> when transmitting. The circuit for the energizing coil of this solenoid is controlled by the same relay that controls the dynamotor solenoid switch. With the change-over switch in the "GEN." position, the brush

1	+ 12 V. FIL.
2	HEATERS
3	FROM 9-D
4	9-D OUTPUT
5	RELAY CONT.
6	SIDETONE
7	200 VOLTS
8	12-A GAIN CONT.
9	GROUND
10	12-A OUTPUT
11	HEATERS
12	

12	TERM. REMOVED
11	-1050 V.
10	+1050 V.
9	GROUND
8	TERM. REMOVED
7	+ 12 V. FIL.
6	SOLENOID
5	HEATERS
4	SPEECH INPUT
3	RELAY CONT.

1	GROUND
2	9-D OUTPUT
3	+ 200 VOLTS
4	+ 12 V. FIL.
5	9-D GAIN CONT.
6	
7	



WIRE DESCRIPTION	TOTAL L'GTH REQUIRED
RED	12 FEET
WHITE	75 "
BLUE	10 "
YELLOW	6 "
No 18 GREEN	8 "
No 16 GREEN	16 "
BLACK	4 "
BLUE & RED	8 "
GREEN & WHITE	16 "
YELLOW & RED	22 "
YELLOW & GREEN	6 "
No 16 TIREX S.S.	66 "
No 16 PACKARD	10 "
No 12 PACKARD	2 "
No 8 PACKARD	10 "
AIRDALE	2 "

NO.	CHANGED	C. O. No.	FROM
C	5-12-33	19058	CHANGED
B	5-1-33	18878	TRACED

SCALE
ALL DIMENSIONS IN INCHES.
DECIMAL DIMENSIONS WITHIN ±
FRACTIONAL " " ±
UNLESS OTHERWISE NOTED
MATERIAL
TREATMENT
FINISH
APPROVED (I.N.A.) (ARMY) DATE

DRAWN	BROWN	1-31-33
TRACED	PLUYLAAR	5-1-33
CHECKED	Carlsen	5-2-33
STRESS CK		
WEIGHT CK		
SHOP CK		
APPROVED	Harding	5-2-33
APPROVED		

26

WIRING DIAGRAM
RADIO EQUIPMENT

ISSUE DATE OF PRINT | ISSUE NO.

BOEING AIRPLANE COMPANY
SEATTLE WASHINGTON

7-934

247
15-2775

solenoid only is actuated; in the "DYN." position, the solenoid switch and the brush solenoid are actuated simultaneously.

Two #16 Tirex conductors are employed between the high voltage connectors on the machine and the Jones receptacle in the special equipment bench located in the radio compartment. These conductors are run through a separate 5/8" solid conduit for their entire length except in the short lengths of 5/8" flexible conduit between the disconnect plug and high voltage fuse box and the end of the 5/8" solid conduit and the equipment bench; this to minimize the possibility of a short circuit. Two pull boxes are provided--one on the front spar aft of the nacelle and one in the fuselage--to facilitate pulling in the Tirex conductors. The high voltage fuse box is located forward of the firewall and along the upper left nacelle member. Access may be had by removing the cowl piece directly above the box. Two extra clips are provided in the box for carrying spare fuses. 3-AG one-ampere capacity fuses are used in the high voltage circuit.

2. Dynamotor- Receiving.- Located to the left of the equipment bench in the radio compartment is one Type M-2749 dynamotor and M-2890 base assembly. The 200 volt output of this machine supplies plate current for the receiver tubes. To facilitate removal or replacement of a dynamotor and filter assembly, four plugs are installed on this unit. These plugs match up with four clips mounted in the base providing an arrangement similar to that described for the generator control box in Section VII. The dynamotor is secured to the mounting base by means of a spring type strap fastener. The 12-volt current supply to the machine is controlled by the switch located on the radio control panel in pilot's cockpit above the radio fuse panel cover.

3. Wiring Diagram.- Dwg. No. 7-934 was prepared especially to show in detail the radio wiring installation. If, and when, changes are made in the original diagram, revised prints will be supplied. It is believed that diagram No. 7-934 will fully serve the purpose for which it was prepared. The size, length, and color code of the conductors used in the radio system are shown on the diagram. No deviation from the diagram should be effected without the approval of the Communications Department.

4. Transmitter and Receiver Mount.- To facilitate removal or replacement of a transmitter or receiver, a special radio equipment bench is installed in the radio compartment. A hinged door provides access to the equipment. This door is secured shut by means of "T" bolt fasteners. The hinge pins are removable to permit removal of the door in case the mail pit is partially filled. The bench is mounted on four Lord rubber shock absorber discs which are secured to the shelf by means of four 3/8" bolts. The holes for these bolts are jig drilled to insure interchangeability.

Installed on the bench is one #238-B jack for test purposes; a 12-point Jones receptacle for the short wave receiver; a 10-point Jones receptacle for the transmitter; a 7-point #644 Yaxley receptacle for the long wave receiver; a B2A special condenser; an Automatic Electric Co. #D-280574 relay; a frequency shift mechanism of the short wave receiver; guide channels and spring loaded catches for holding the receivers and transmitter in place. The fitting in which the #644 Yaxley receptacle is mounted is designed in a way such that it may be rotated and locked in the desired position; this to accommodate proper alignment of the holes in the receptacle with the pins in the jack. After the receptacle is screwed into the fitting tightly, it is only necessary to loosen the four machine screws used to secure the fitting to the box shell, rotate to the correct position, and tighten the screws. Manufacturing details of the bench assembly are shown on Dwg. No. 15-2900 and its installation on Dwg. No. 15-2775.

5. Frequency Shift Mechanism.- This device consists of two flexible shafts and a push-pull knob located on the upper right corner of the pilot's control stand and directly below the radio control panel. The two flexible shafts are operated by a single knob. They are connected to the frequency shift levers--one on the transmitter, the other on the radio bench. As designated on the knob, the control should be pushed "IN, for DAY", and pulled "OUT, for NIGHT" frequency. These mechanisms are installed on airplanes NC-13319 and subsequent articles. Necessary parts for installation on NC-13301 to NC-13318 inclusive are being manufactured. These airplanes were delivered prior to the adoption of the remote frequency shift control.

6. Control Panel and Switches.- Located on the right side of the pilot's control stand is a special hinged cover panel containing the radio system fuses, switches, and rheostats. The wiring of these units is clearly shown on Dwg. No. 7-934. Located adjacent to this panel is one WECO 1A

tuning unit--"coffee grinder"--for the long wave receiver. A 6-foot flexible shaft is employed between the 1A unit and the receiver. To simplify identification of the switches and controls, the control handle of the 1A unit and the volume control knob and switch for the long wave receiver are painted red; the volume control knob and switch for the short wave receiver are painted blue. The two #260-C Edwards switches installed in the inboard horns of the pilot's and co-pilot's control wheels are designated by blue bands painted around the wheel rims. When either of these switches is depressed with the "Rec.-Trans." switch in the "transmit" position, the high voltage generator becomes operative for transmitting. When depressed with the "Rec.-Trans." in the "receive" position, intercommunication between the pilot and co-pilot is established.

7. Jack Boxes.- Located on the right and left cabin wall just below the side windows is one each 238-B jack mounted in a small metal box. Two lengths of 5/16" solid conduit are run from these boxes forward to a junction box in the radio compartment above the receiving dynamotor. These jacks are provided for attachment of pilot's and co-pilot's transmitter and head set plug.

8. Antenna System.- This system consists of a streamlined dural tubular mast mounted forward of the pilot's cabin through the top surface of the fuselage with external cable braces; a Transmitting and Short Wave receiver antenna from the top of the mast to a fitting on the leading edge of the vertical fin; a Long Wave receiver antenna leading from a lug aft of the mast up to but insulated from the transmitting antenna. Phosphor bronze 7 x 24 gauge cable is used for the antennaes; #804 Isolantite insulators are employed to insulate electrical conductors and brace cables from the airplane structure. Details of the mast and antenna installation are shown on Dwg. No. 6-2995 and 6-2998. The lower end of the mast is insulated from the structure and supported by means of micarta panels. After installation of the panels and the mast, all cracks were filled with solo rubber compound to prevent leakage of water into the radio compartment. Extreme care must be exercised at all times to insure against leakage at this point. It is also most important that the micarta plates and Isolantite insulators be kept spotlessly clean. Collection of any foreign substance, especially carbon deposits from soot, will impair reception as well as increase the hazards of the high or radio-frequency current jumping or shorting to ground. These should be periodically wiped clean.

9. Bonding.- The airplanes are bonded throughout according to Boeing Specification BE-1, which specification was prepared in accordance with data submitted and approved by the Communications Department of the United Air Lines. Ungrounded lengths of tubing are bonded to the structure at intervals not to exceed 36"; jumpers are provided at hose connections in the oil system. Tests indicated that jumpers were not necessary at hose connections in the fuel system in which hose liners were employed. Jumpers are also provided at control cable turnbuckles, clevises, etc. A copy of Specification BE-1 (D-770) for use at main overhaul bases will be furnished on request.

SECTION XIV

UNSATISFACTORY PERFORMANCE CHARTS

For the past four years the Engineering Department of the Boeing Airplane Company has been materially benefitted from the data submitted on Boeing Unsatisfactory Performance Charts by operators of Boeing Model 40-B, 40-B4, 80, 80-A, and 95 airplanes. On numerous occasions it has been possible to very definitely determine the cause of unsatisfactory functioning of certain items of equipment or sub-assemblies on the airplanes. At first perusal of the chart it may appear that the information requested is of slight consequence. This is not the case. The majority of service personnel are primarily concerned with their own particular problems, and fail to appreciate the designers task of producing an airplane capable of carrying the greatest payload at maximum speed and still meet the strength requirements. Therein lies the purpose of these charts. To meet the exacting speed and strength requirements and still produce an airplane capable of satisfactory performance over extended periods of operation, the designer must have first hand information on the serviceability of the accessories and sub-assemblies. In this way only is he able to appreciate the problem confronting the operators in maintenance and service.

We urgently request your earnest cooperation in submitting the charts to us. It should not be difficult for one man at operations headquarters to make notations from pilot's and/or mechanics reports on the charts weekly or monthly. We do not care for lengthy explanations covering the difficulties. We want only to know the item or part of the airplane which requires constant servicing, replacement, or repair. If, for example, it is found over periods of time that oil tanks, wing leading edges, nacelle structures, air intake ducts, ring cowls, etc. require considerable servicing, replacement or repair, we can immediately take steps to ascertain the exact nature of the difficulties. With this information at hand, the problem of redesign is minimized.

Shortly after release of this manual a number of blue line prints of Dwg. 6-1366 will be supplied to operators of the Model 247 airplanes. If additional copies are desired, they will be gladly supplied on request.

This manual was prepared by:
SERVICE UNIT, ENGINEERING DEPT.
BOEING AIRPLANE COMPANY
SEATTLE, WASHINGTON

UNSATISFACTORY PERFORMANCE CHART

BOEING MODEL 247 TRANSPORT AIRPLANE

POWER PLANTS

PROPELLER	RING COWL	SHUTTERS	IGN. SHEILDING	MAGNETOS	STARTERS	EXH. MANIFOLDS	CARB. HEATERS	" AIR VALVE	NACELLE STRUCT.	ENG. MOUNTS	COWLING	FIRE EXT. SYS.

FUEL SYSTEM

TANKS	ENG. PUMP	HAND PUMP	STRAINERS	CONT. VALVES	RELIEF VALVES	AIR SEPERATORS	PIPING	FILLER UNITS	HYD. GAGE EL'M'TS.	VENTS	WARNING DEVICES

OIL SYSTEM

TANKS	COOLERS	PIPING	VALVES	M'T'G. BRACKET

ELECTRICAL SYSTEM

DYN.-GENERATOR	CONTROL BOX	BATTERY	MASTER SW.	CHANGE OVER SW.	DYN. SOL. SW.	WIRING	JUNCTION BOXES	FUSES	SWITCHES	THERMOCOUPLES	LAND'G. LIGHTS	CABIN "	INSTRU. "	NAVIGATION "	BOOSTER SYS.

LANDING GEAR

RETRACT. MOTOR	CLUTCHES	SWITCHES	DRIVE MECH.	HAND DRIVE	SCREWS	WHEELS	TIRES	OLEOS	BRAKES	HYD. SYS.	AXLES	BEARINGS	STRUTS	WARNING DEVICES	POSITION IND.	PARKING BRAKE

CONTROL SURFACES & SYSTEMS

FIN	HORIZ. STAB.	RUDDER	ELEVATOR	AILERON	RUDDER FLAP	ELEVATOR "	AILERON "	RUD. CONT. CABLES	ELEV. "	AIL. "	CONT. MOTORS	ENGINE CONTROLS	RAD. & SHUT. "	CARB. AIR "	SURFACE HINGES

FUSELAGE ASSY.

NOSE STRUCTURE	CENT. SECT. "	REAR "	CARGO PITS	PIT DOORS	PASSENGER "	SKIN	COWL. FILLETS	CABIN LINING	PASSENGER SEATS	WINDOWS	VENTS	PARCEL RACKS

WING

SPARS	STRUCTURE	COVERING	INSPECTION DOORS	TIPS	TRAILING EDGE	LAND. LGT. WELLS

HEATING SYSTEM

BOILER	CONTROL MOTOR	PIPING	THERMOSTATS	LIQUID PUMP	AIR DUCTS	GRILLES	RADIATORS	FANS

VACUUM SYS.

VAC. PUMP	PIPING	ECLIPSE VALVE	KELLY VALVE

RADIO SYSTEM

TRANS. DYN.	RECEIVING. DYN.	CONTROL PANEL	FREQUENCY SHIFT	WIRING	ANTENNA SYS.	EQUIP. MOUNT	BONDING	SHEILDING

INSTRUMENTS

MAIN BOARD	SUB - PANELS	DIR. GYRO-ART. HOR.	COMPASS	THERM. IND. & SW.	TACHOMETERS	OIL TEMP. INDS.	OIL PRESS. GAGES	FUEL "	IGNITION SW.	FUEL GAGES	ENGINE PRIMER	CLAROSTATS	SWITCHES	AIR SPEED IND.

– EXPLANATORY NOTE –

DESIGNATE BY SMALL CIRCLE (AS "o") IN SPACE SO PROVIDED EACH MAINTENANCE DIFFICULTY EXPERIENCED IN SERVICE WITH THE PART OR UNIT DUE TO FAILURE, REPAIR OR REPLACEMENT.

EXAMPLES:– RETRACTING GEAR MOTOR FAILS – EXAMINATION INDICATES BRUSHES WORN – DESIGNATE BY "o" UNDER LANDING GEAR, RETRACT. MOTOR. OIL TANK LEAKING – DESIGNATE BY "o" UNDER OIL SYSTEM, TANKS. TRANSMITTER FAILS TO FUNCTION – EXAMINATION INDICATES SOLENOID SWITCH FAILURE – DESIGNATE BY "o" UNDER ELECTRICAL SYSTEM, DYN. SOL. SW. ETC., ETC.

TO SERVICE UNIT ______ ______ ENGINEERING DEPT.

BOEING AIRPLANE COMPANY ______ ______ ______ ______ SEATTLE, WASH.

SUBMITTED BY________________ SIGNED________________

MONTH OF______________19

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