CARBURETORS

General Description

1. The Stromberg Model PD12H4-1 or PD12F5-1 Injection Carburetor is a down draft carburetor and is mounted on the engine in exactly the same manner as the standard suction type carburetor. This carburetor differs from the suction type carburetor only in the manner in which the fuel is regulated and delivered to the airstream. In the injection type carburetor, the fuel is pumped (under pressure from the fuel pump) through the carburetor and discharged through the discharge nozzle into the adapter just below the carburetor; where as in the suction type carburetor the fuel is merely pumped into the float chamber by the fuel pump; then it is forced from the float chamber and out the discharge nozzles by the differential between the impact air pressure and the venturi suction pressure.

2. Understanding the construction and operation of the carburetor in made easier by the fact that it is subdivided into separate units, each of which has its individual and function.

Throttle Unit

3. The throttle unit of injection carburetor is quite similar to that used with conventional float type carburetors. It has a butterfly type throttle valve, a large and a small venturi, a throttle balance, provision for mounting an automatic mixture control unit, and a flange for mounting the regular unit. A manually operated valve to by-pass the automatic mixture control and make it inoperative is also included in the throttle body design.

4. The suction at the throat of the small venturi is a measure of the amount of air entering the engine. This suction, when corrected by the automatic mixture control unit for changes in air density, becomes a measure of mass air flow and is applied to the air diaphragm of the regulator unit to regulate the fuel metering pressure (or head) across the fixed jets in the fuel control unit.

Automatic Mixture Control Unit

5. This unit consists of a sealed metallic bellows operating a contoured valve. The bellows is filled with a measured amount of inert gas to make it sensitive to changes in temperature and pressure. The valve, therefore, has a predetermined position for each air density encountered in flight.

Regulator Unit

6. The regulator unit automatically adjusts the fuel pressure across the metering jets and therefore, the fuel flow in proportion to the mass air flow through the throttle body. The unit is made up of an air diaphragm, a fuel diaphragm, a sealing diaphragm, a balancing diaphragm and a balanced fuel valve all mounted on onestem supported by suitable guides. Fuel enters through a strainer, passes through the poppet valve to one side of the fuel diaphragm chamber and then to the jets in the fuel control unit. A vapor separator is provided in the fuel strainer chamber to prevent vapor entering the regulator. A line from the vapor separator to the respective main tank may return fuel at a rate of approximately 5 - 10 gals/hr.

Adapter

7. As its name implies, the adapter is mounted between the carburetor throttle body and the engine, and contains the "X"-bar spray nozzle and acceleration pump. Metered fuel from the Fuel Control Unit enters the adapter and follows a passage to the spray nozzle acceleration pump. When the pressure of the fuel on the nozzle diaphragm reaches 4 to 5 p.s.i., or the pressure at which the nozzle spring is set to open, the force of the spring is overcome and the nozzle opens discharging fuel into the supercharger entrance. The nozzle will remain open permitting the discharge as long as the pressure does not drop below 4 to 5 p.s.i. The double Diaphragm Acceleration Pump is automatically operated by vacuum causing an accelerating discharge through a spring operated discharge valve and a separate discharge nozzle arranged to spray the charge directly into the airstream to the supercharger entrance as well as causing an accelerating discharge through the regular spray nozzles. The accelerating pump draws in a charge under low pressure when the throttle is closed, and discharges on rise of pressure when the throttle opens.

8. If the mixture control is moved out of the IDLE CUT-OFF position any fuel above 4 or 5 p.s.i. will flow through the discharge nozzle into the adapter and down to the blower section.

9. (Unassigned)

10. (Unassigned)

Fuel Control Unit

11. This unit, attached directly to the regular unit, contains the metering jets, an idling needle and a manually operated mixture control and mixture selection valve. The idling needle is mechanically connected to the throttle and controls the mixture through out the idling range of speeds. The manual mixture control provides EMERGENCY (FULL RICH), TAKE-OFF and CLIMB (AUTOMATIC RICH), CRUISE (AUTOMATIC LEAN) and IDLE CUT-OFF positions.

12. The carburetor is provided with a manual mixture control which may be set from the control pedestal in the pilots' compartment to give any one of the following positions:

(1) Emergency ~~(Full Rich)~~:

In this position the automatic mixture control by-pass is open leaving the carburetor without automatic compensation for altitude or temperature. At Sea Level and Standard Temperature the fuel flow in TAKE-OFF and CLIMB is approximately the same as the fuel flow in the EMERGENCY position. The increase in richness above TAKE-OFF and CLIMB fuel flow provided by operation in this position increases with altitude.

(2) Take-Off and Climb (Automatic Rich):

Usual operating position, automatically maintaining the desired fuel/air ratios at all engine speeds and loads, independent of changes in altitude temperature, propeller, pitch, supercharger speed and throttle position. In this setting the port openings are exactly the same as the openings in the EMERGENCY position. At the TAKE-OFF and CLIMB position, however, the by-pass valve is closed thus making the automatic mixture control unit operative.

(3) Cruise (Automatic Lean):

A leaner setting than TAKE-OFF and CLIMB and suitable for cruising under favorable conditions. This setting may be too lean for good acceleration. When the manual mixture control is in this setting the automatic rich jets are closed allowing fuel to flow only through the automatic lean and the two vent jets. The automatic mixture control is also operative in this position.

(4) Idle Cut-Off:

Moving the mixture control past CRUISE to the end of its travel closes all ports. This will completely stop all fuel flow to the carburetor nozzle, regardless of fuel pressure or throttle opening. This position is intended principally for stopping the engine without the hazard of backfiring.

(5) Intermediate Positions:

Each position of the mixture control has a tolerance of about five degrees plus or minus at the carburetor. Between positions there is a fairly uniform transition in its effect on the mixture delivered by the carburetor. Between EMERGENCY and TAKE-OFF and CLIMB the transition varies in its rate and amount, depending upon the density of the air entering the carburetor as affected by temperature and altitude. CRUISE (Automatic Lean) is five to ten percent leaner than TAKE-OFF and CLIMB (Automatic Rich) depending upon the particular carburetor setting. Between CRUISE and IDLE CUT-OFF, further reduction in mixture strength is attainable by manual control primarily for use when the automatic mixture control may not function properly due to damage. Manual leaning beyond the CRUISE position is not to be done.

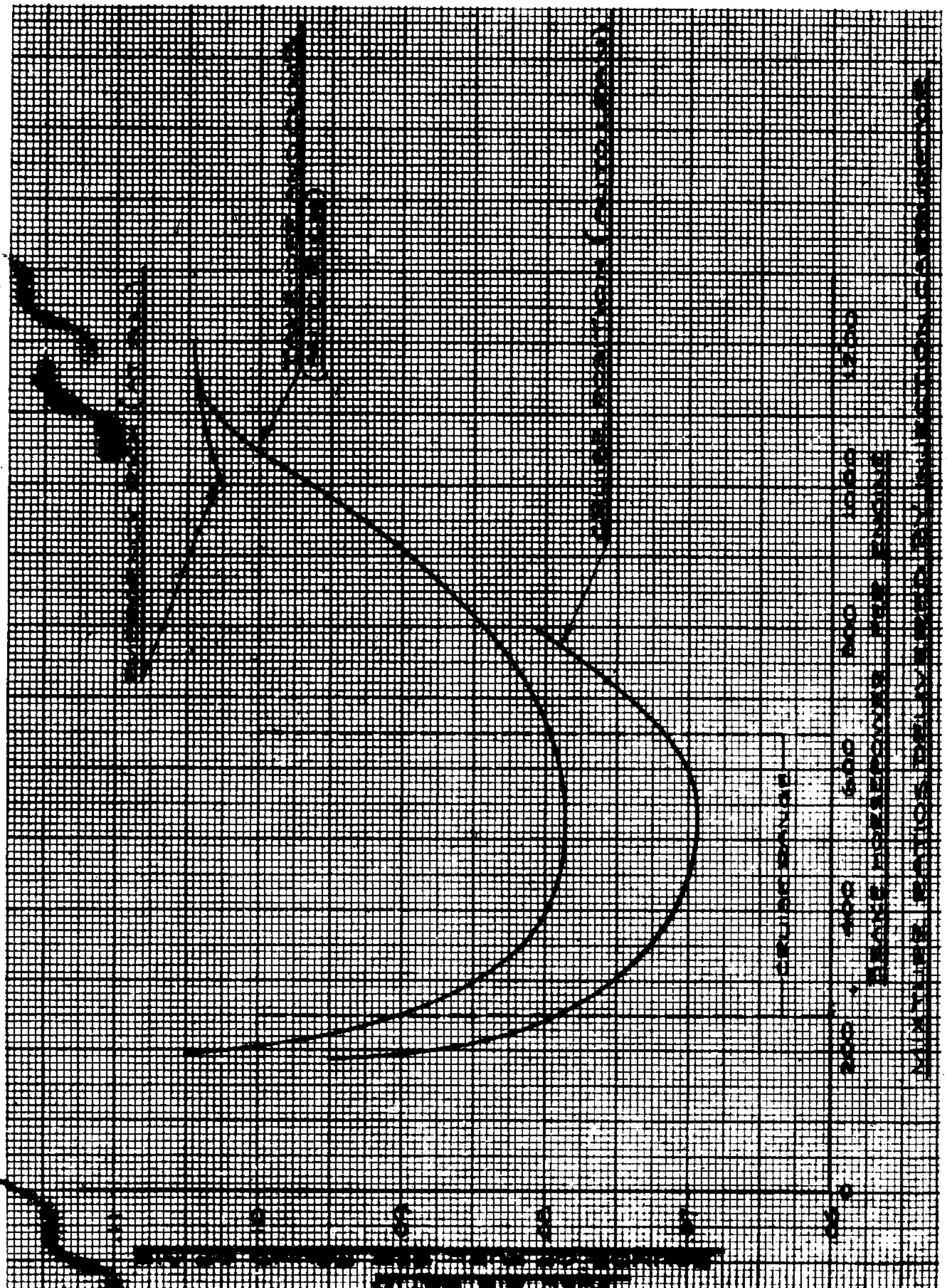
Manual leaning may cause severe damage to the engine unless done in accordance with well-established instructions.

Air Induction System

13. The carburetor air scoop is of the ramming type where in a small scoop located on the top forward edge of the engine accessory cowling accepts air from the airstream routing it direct to the carburetor scoop adapter. No provision is made for filtering either cold or hot air intakes.

Carburetor Preheat

14. The carburetor air scoop of each engine is fitted with a hot air intake door which is operated mechanically by a lever on the right hand side of the control pedestal. A single locking lever locks the two carburetor heat levers in any desired position. As the door is opened to hot air intake it proportionately closes off cold air intake, making close control of the carburetor air temperatures possible. Preheating of the air intake is accomplished by passing it through a partial enclosure around a section of the exhaust collector ring just ahead of the hot air intake door.


CRUISE POSITION (AUTO LEAN)
CRUISE RANGE
0
200
400
600
800
1000
1200
BRAKE HORSEPOWER PER ENGINE
MIXTURE RATIOS DELIVERED BY INJECTION CARBURETOR

FUEL SYSTEM

Description of Fuel System

1. The fuel system consists of four fuel tanks, two tank selector valves, two electric fuel booster pumps and two fuel strainers mounted within the wing center section, an engine-driven fuel pump mounted on each engine and an electrically operated primer.

2. Each engine is supplied by a separate fuel system; that is, the right engine normally draws fuel from the right tanks and the left engine from the left tanks. However, either engine can use fuel from any tank since each fuel tank. The electric fuel booster pumps are used for starting and for auxiliary source of pressure in the event of engine pump failure. The carburetor vapor vent return lines are connected to their respective Main (Front) tanks.

3. The total capacity of the fuel tanks is 670 Imperial gallons (usable); 168 Imperial gallons in each front tank, and 167 Imperial gallons in each rear tank.

Using Fuel and Draining the Tanks

4. Normally, starts, taxiing operations, take-off, climbs and landings will be made on the Front tanks with the Left Front tank supplying the left engine and the Right Front supplying the right engine. This is extremely important when operating under conditions of higher power to reduce the possibility of vapor lock.

(continued)

5. Upon reaching cruising altitude the procedure for using fuel is as follows:

(1) Use rear tanks first. Left engine on left tank, right engine on right tank.

(2) First rear tank to reach 25 gallons, switch engine to front on same side.

(3) Let opposite engine run rear tank down to 10 gal. then switch to front tank.

(4) Run the other engine in rear tank until she also reach 10 gal. then switch to front.

NOTE: To prevent the possibility of running two tanks dry simultaneously, <u>do not drain two tanks below 25 Imperial gallons at the same time</u>. When running an engine on a tank with less than 25 Imperial gallons of fuel or when running a tank dry, switch the opposite engine to the next tank to be used. When draining a tank below 25 Imperial gallons watch the fuel pressure gauge of that engine.

6. When it is necessary to conserve fuel, tanks can be drained to approximately two gallons by flying 3° to 5° wing low on the side opposite the tank being drained and in a slight climb.
Never feed both engines from one tank with less than 40 gallons in that particular tank.

Filling Fuel Tanks

6. The minimum quantity of fuel with which it is permissible to dispatch the airplane on any flight, from any station, is to be 150 Imperial Gallons which must be distributed in the following order:

   (1) Under all conditions each rear tank must carry a minimum of 10 Imperial Gallons.
   (2) The remainder 130 Imp. Gals is to be evenly distributed between the two front tanks.
   (3) The tanks under this condition are to be filled in the following order:
       (a) Left Front tank and Right Front tank - 65 Imp. Gals each tank.
       (b) Left Rear tank - 10 Imp. Gals.
       (c) Right Rear tank - 10 Imp. Gals.

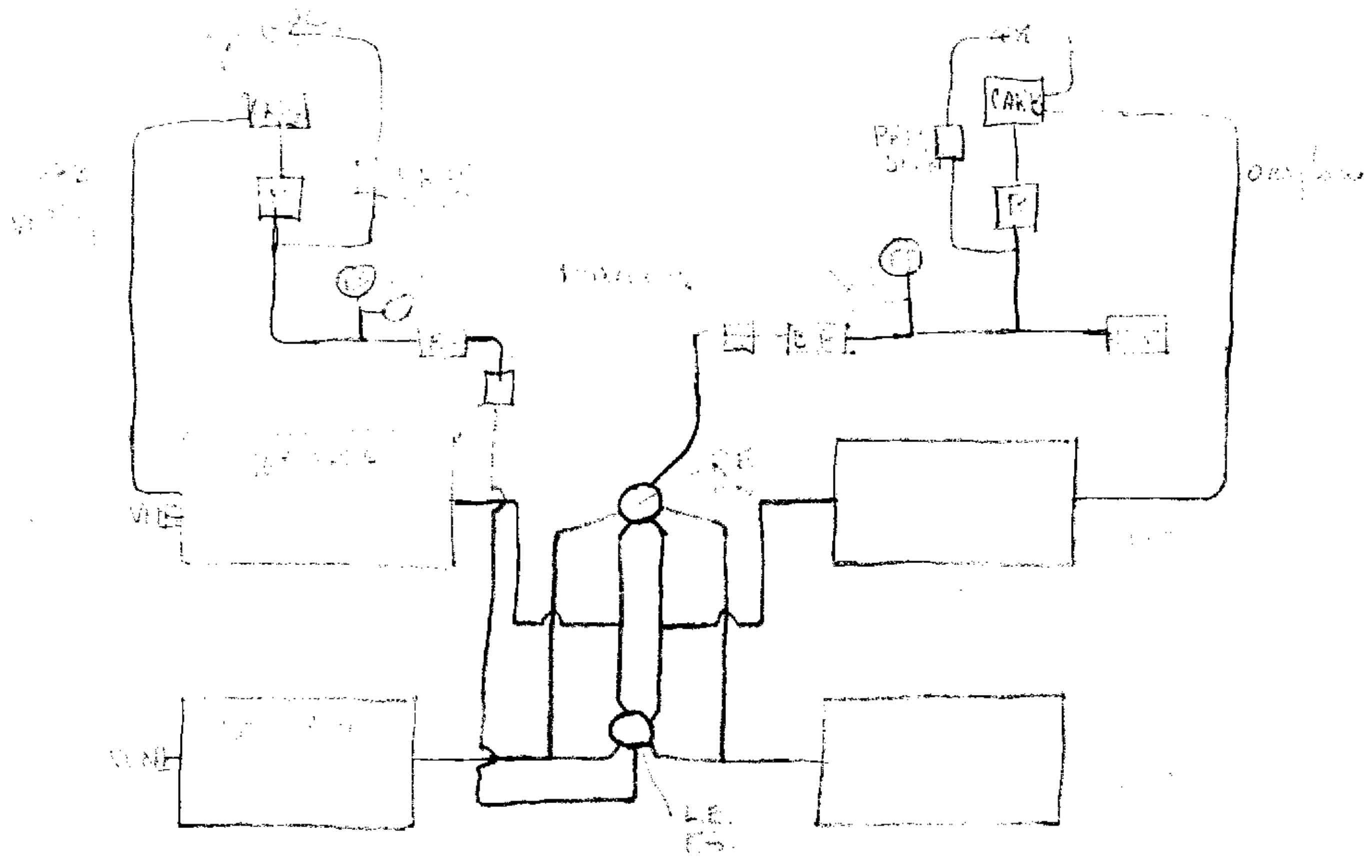
7. When the total fuel load for dispatching is greater than 150 Imp. Gals. the fuel is to be distributed on the following order:

   (1) Under all conditions each rear tank must carry a minimum of 10 Imp. Gals.
   (2) The remainder of the total fuel load is to be evenly distributed in the two front tanks if possible.
   (3) The remainder of the fuel, if any, is to be loaded evenly in rear tanks.

8. An aircraft may be dispatched with more than 10 gals. of fuel in each of the rear tanks, even through the front tanks are not filled to capacity, provided the total required amount of fuel is on board and there is the minimum of 65 Imperial gallons in each of the two front tanks.

Fuel Supply - "Janitrol" Heater Unit

9. Provision is made to supply fuel to the heater unit from the fuel supply line to the right engine. Althrough the fuel utilized by the greater will average only approximately 1 Imp. Gal. per hour, this should not be neglected in computing fuel consumption for the flight.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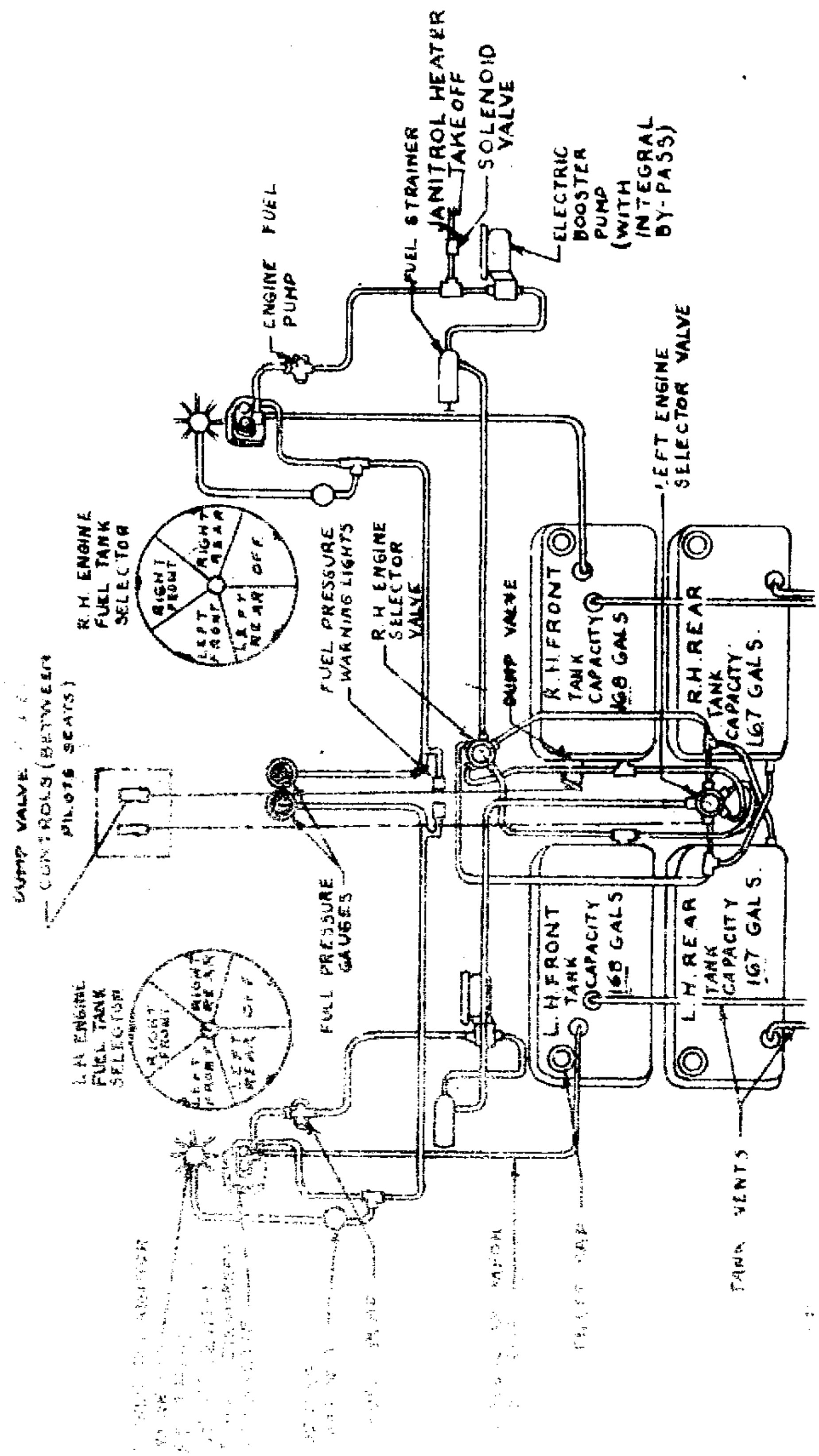


DC-3
FUEL SYSTEM
R-1830-S1C3G(-92) ENGINES

OIL SYSTEM

Description of Oil System

1. A complete oil system is provided for each engine, consisting of an oil tank, a diffusion type oil cooler, an oil temperature regulator and the necessary lines and connections. Oil is drawn from the tank through a supply line to the engine driven pressure pump, whence it is forced under pressure to all parts of the engine requiring lubrication. The heated oil from the engine is returned by the engine driven scavenge pumps to the oil cooler. Under normal conditions, the oil flows through the cores of the cooler dissipating heat to the airstream, or it may be by-passed direct to the return line to the tank, by the oil temperature regulator which is described in a following paragraph. No shutters are provided for the oil coolers, since the oil temperature regulator relieves the pilot of the necessity for manually controlling temperature. ~~An immersion heater for ground use, operating from an external 110V. source of supply is installed in each tank.~~ Two breather lines extend from the tank to the engine and two lines vent the engine to the air, one to the top front of the nacelle and the other to the bottom rear. The electrically driven feathering pump, when operated, draws oil through a separate supply line from the tank and delivers to the propeller governor unit.

Capacity

2. The capacity of each tank is 24 Imperial gallons to the filler neck, with a $2\frac{1}{2}$ Imperial gallon allowance for expansion. USE 18 GALS

Hot Oil Hopper

3. A hopper is built inside of each tank to convey the heated oil from the return line to a point directly over the tank outlet. The outlet fitting contains a standpipe which maintains a one gallon reserve of oil for the propeller feathering system.

(continued)

OIL SYSTEM

Oil Pressure and Temperature Gauges

4. The pressure is taken directly from each crankcase by a line which passes through connections in the firewall, through the nacelle and centre section and then forward to the direct reading oil pressure gauge on the Instrument Panel. The oil temperature gauge is electrically operated from a thermometer resistance bulb in the rear accessory case of each engine.

Oil Temperature Regulation

5. The oil temperature is automatically controlled by a thermostatically operated oil temperature regulator valve for each engine. This valve is mounted at the top of the oil cooler. When warning up or when the oil temperature goes below the normal operating range, the thermostat operates the valve to by-pass all the oil flow past the cooler direct to the tank. As the temperature increases progressively, the thermostat operates the valve to direct an increasing proportion of the oil flow down into a main oil passage which divides the diffusion oil cooler core vertically. Small holes are drilled at intervals in this passage from top to bottom, through which the warm oil passes out through the core to the sides. Thus when the flow of warm oil is proportionately small, the cooling circulation takes place only at the top of the cooler; and as the oil temperature increases, and consequently the quantity of oil circulated to the cooler by the valve, an enlarging pattern of circulation is built up in the cooler core from top to bottom and fully automatic temperature control is there by obtained.

OIL DILUTION

1. GENERAL

To ensure easy start during cold weather operation, oil dilution will be performed in engines of all Q.B.A. aircraft from September 1st to April 30th.

To standardize oil dilution, the following procedure should be adhered to.

Where propeller equipment requires that dilution procedures differ, relevant paragraphs have been specifically headed, i.e. sub paras. C.5, C.6, D.1. (a) and D.2 (2).

As soon as dilution is performed at the commencement of cold weather operation, the diluted oil will wash down sludge into the engine filters or screens. It is, therefore, imperative, that the filters or screens be removed at each major, stop, for inspection and cleaning until the sludge no longer appears.

2. WHEN TO USE

(1) If the outside air temperature is between - 1°C and -18°C, and the engines are to be stopped for more than one hour.

(2) If the outside air temperature is below -18°C, and the engines are to be stopped for more than fifteen minutes. (See Para. E).

WHEN STOPPING ENGINES

(1) After taxiing to the point of unloading, the engines will be stopped for a short time while passengers are being unloaded, etc. Head temperatures should not be allowed to fall below approximately 52°C, since lower temperatures may cause hand re-starting.

(2) The engines will be re-started and set at 800 to 1000 R.P.M. (Ref. Para. F.1).

(3) The oil temperature should be some what below 38°C. The oil temperature should not exceed 49°C, during the dilution operation because the gasoline will distill off at higher temperatures. An exception to this rule is described in Para. E.

OIL DILUTION

4. <u>WHEN STOPPING ENGINES (CONT'D)</u>

(4) Operate the oil dilution control for the following periods:

Outside Air Temp. (°F)	(°C)	Ground Dilution Period (Min)
Above + 25	Above -4	3
+ 25 to -10	-4 to -23	4
-10 to -25	-23 to -32	5
-25 to -35	-32 to -37	6
Below -35	Below -37	7

(5) <u>HYDRAULIC PROPELLER EQUIPMENT</u>

(a) After the first three minutes of oil dilution increase the engine speed to 1800 R.P.M. and move the propeller pitch control to the high pitch position. Allow the propeller to change pitch, which will be indicated by a decrease in R.P.M. of approximately 600 or more, and then return, the propeller pitch control to the low pitch position. (Ref. Para. F.3)

(b) Continue to operate the engine at 1800 R.P.M. and close the propeller feathering switch until a drop of 400 R.P.M. is indicated, Manually return the switch to the open position.

(c) Repeat operation 5 (b) preceding for each succeeding minute of dilution.

(d) With the propeller in low pitch, open the throttle to approximately 100 R.P.M. and place mixture control in idle cut-off position. Continue to hold the oil dilution valve open until the engine has stopped. Ref. D.L. (a).

(6) <u>CONSTANT SPEED OR TWO POSITION (CONTROLLABLE) PROPELLER EQUIPMENT.</u>

(a) After the first three minutes of oil dilution increase the engine speed to 1400 R.P.M. Move the propeller pitch control to the high pitch position. Then return the pitch control to the low pitch position.

(b) Reduce engine speed to approximately 100 R.P.M. and complete dilution period.

OIL DILUTION

(6) CONSTANT SPEED OR TWO POSITION (CONTROLLABLE) PROPELLER EQUIPMENT (CONT')

(c) Move propeller to high pitch position and stop engine in normal way. Continue to dilute until engine has stopped. By leaving the propeller in high pitch, the propeller will not rob the engine of oil when the "cold start" is made. Ref. Para. D.2(a)

5. WHEN STARTING ENGINES

1. HYDRAULIC PROPELLER EQUIPMENT

(a) Start engine in normal manner, with propellers in low pitch.

2. CONSTANT SPEED OR TWO POSITION (CONTROLLABLE) PROPELLER EQUIPMENT.

Start engines with propellers in high pitch and run for approximately two minutes before changing to low pitch. If this is not done the engine will be robbed of oil when starting.

3. If heavy viscous oil is indicated by a high or fluctuating oil pressure, decreasing when R.P.M. is increased, hold oil dilution control open to correct the condition.

4. Over dilution will result in a low steady oil pressure. Engine should be ground-run long enough to evaporate excess gasoline from the oil in order to obtain approximately normal oil pressure.

5. Take-off may be made when oil pressure and oil temperature are steady and approximately normal.

6. WHEN APPROACHING AIRPORT OR TAXIING AFTER LANDING

1. Operate the oil dilution control for the following periods:

Outside Air Temperature (°F)	(°C)	Approach or Taxi Dilution Period (Min)
above 0	above -18	None
0 to -15	-18 to -26	1
Below -15	Below -26	2

2. The oil temperature during the above procedure should not be lower than 75°C.

OIL DILUTION

6. WHEN APPROACHING AIRPORT OR TAXIING AFTER LANDING (CONT'D)

3. This procedure (1 and 2 above) is intended only to ensure circulation of diluted oil through the oil cooler, and does not preclude the required ground dilution described in Para. C.

4. Since the oil temperature drops rapidly during the landing approach and subsequent taxiing, the oil cooler by-pass valve will close. This traps undiluted oil in the oil cooler unless Items 1 and 2 above are followed. If undiluted oil should remain in the cooler, this unit may burst during the succeeding run up or take-off due to excessive back pressure.

7. NOTES

1. If oil is required it must be added before ground dilution is carried out. This, is before the engines are started per Para. C.2

2. Fuel and oil pressures will decrease during the dilution period. The engines must not be run with zero oil pressure.

3. Oil pressure during maximum R.P.M. run (Paras C.5 (a) and C.6 (a) should not be lower than 50 p.s.i. Oil temperature prior to starting the maximum R.P.M. run should be approximately 38°C -- lower oil temperatures may cause poor lubrication at high R.P.M.

4. On DC-3C aircraft the oil level should be checked before dilution to ensure that each tank contains not more than 20 gals. Otherwise the addition of a gallon or more of gasoline may result in loss or wastage of oil.

   After a warm-up run, during which the diluting gasoline is evaporated (Para. D.4), oil should be added as required to fill the tank (total capacity 22 gals.)

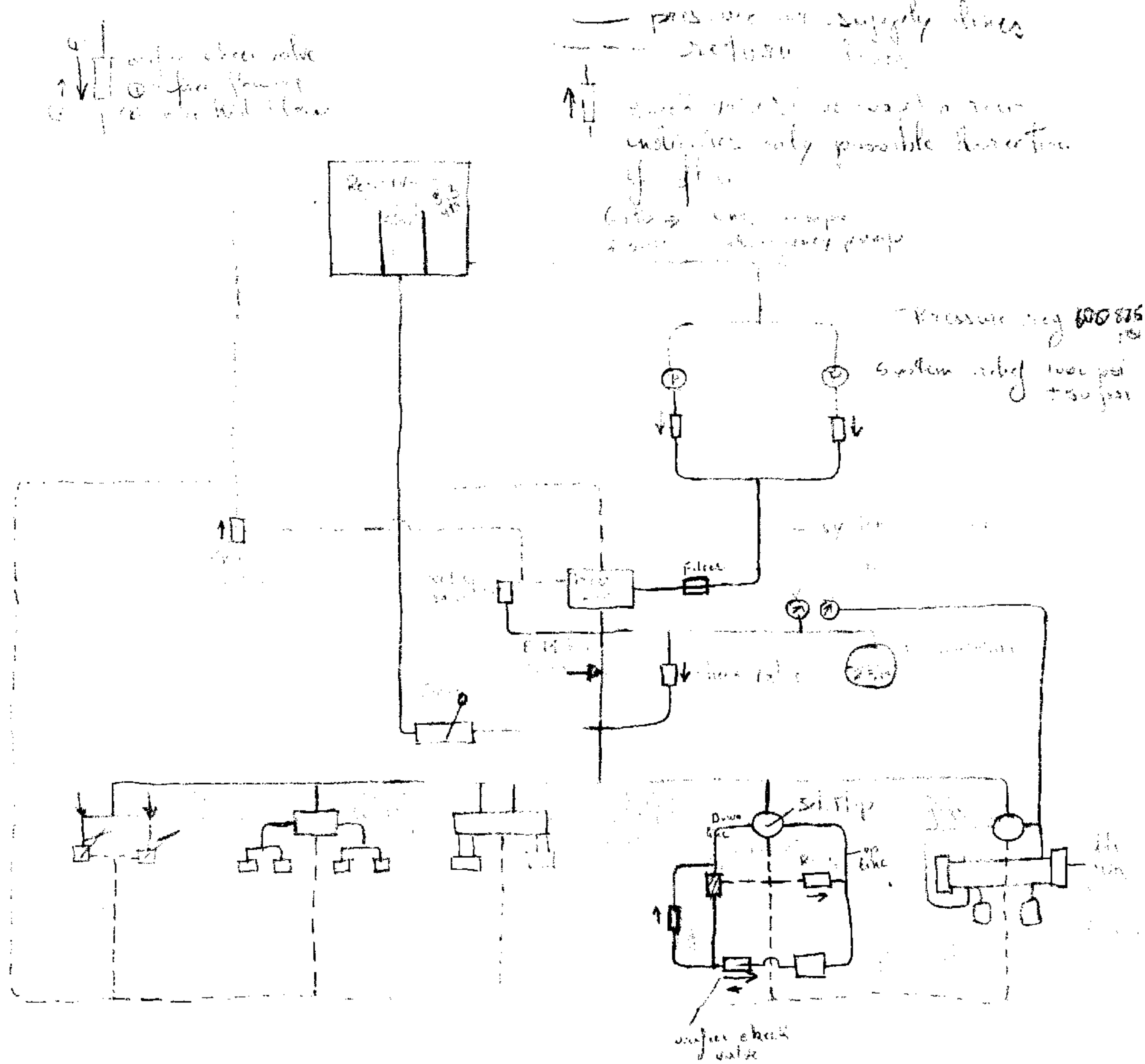
HYDRAULIC SYSTEM

1. The hydraulic system consists of the equipment necessary to operate the landing gear, wheel brakes, wing flaps, cowl flaps and windshield wipers. Two engine-driven hydraulic pumps, one mounted on each engine, supply fluid under pressure to the system.

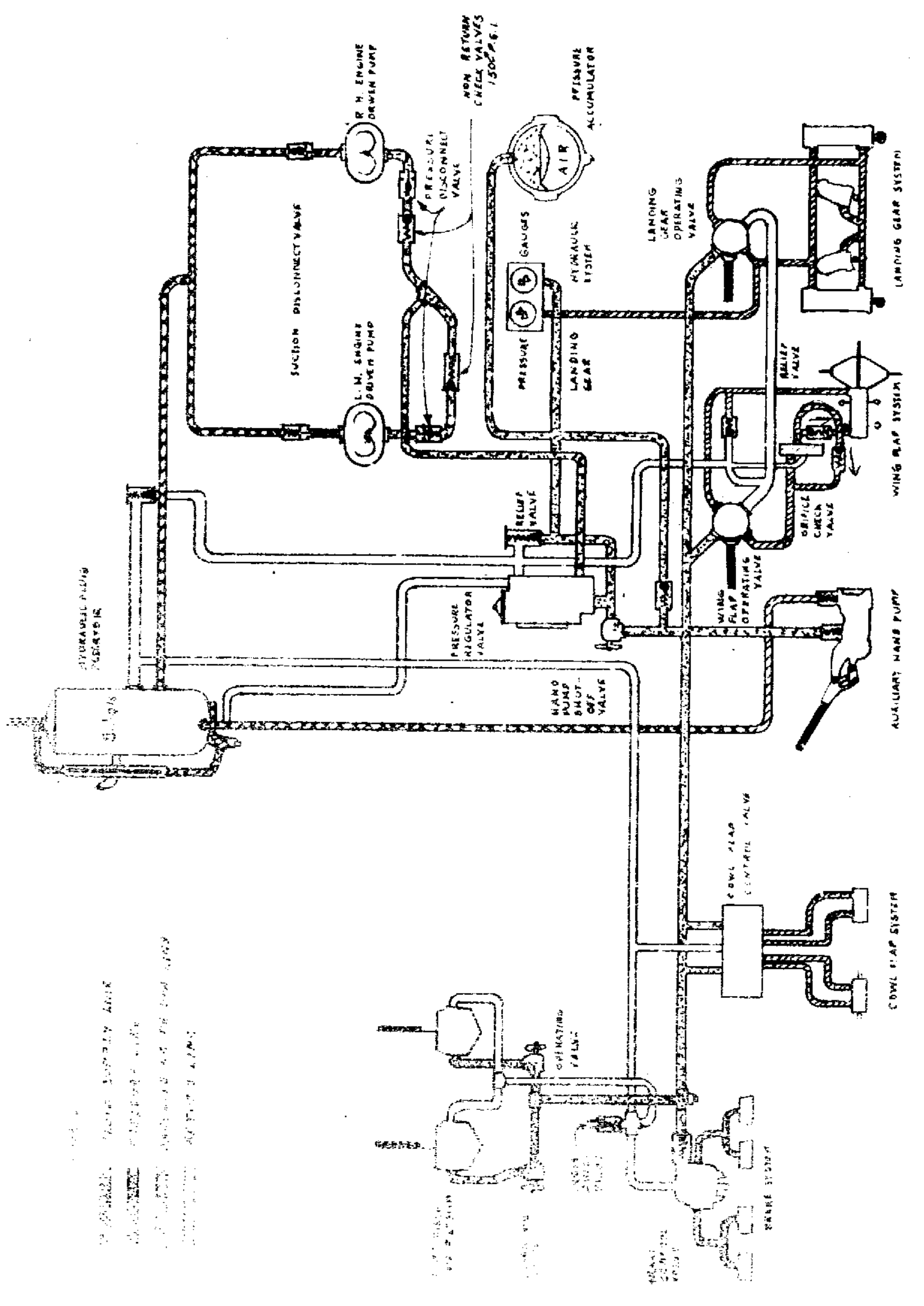
2. Hydraulic fluid is supplied by gravity feed from the reservoir to the hydraulic pump on each engine and then, under pressure, flows through check valves to a common line to the hydraulic pressure regulator. The regulator maintains a normal system operating pressure of 600 - 875 psi. The pressure in a hydraulic accumulator and in the system itself, is controlled by the pressure regulator. If the regulator fails, any build up of pressure in the line in excess of 100 pounds opens a system relief valve adjacent to the regulator and by-passes the excess fluid back to the reservoir. A hydraulic hand pump is installed on the hydraulic control panel to provide pressure to operate any of the various units in the event both engine-driven pumps fail or are inoperative or there is insufficient pressure. If one engine-driven pump fails or is inoperative because the engine is feathered or otherwise inoperative, then the operative pump will maintain the desired pressure in the system. A check valve in the line from the inoperative pump prevents any reverse flow and loss of pressure.

3. Two hydraulic pressure gauges are mounted on the right side of the Main Instrument Panel. The gauge designated "Hydraulic System" in dicates pressure from the regulated side of the system pressure regulator and therefore of the main system. The "Landing Gear" gauge is connected direct to the "down" line to the landing gear actuating cylinders and indicates pressure in the landing gear system.

4. The hydraulic fluid reservoir is mounted behind the hydraulic control panel and is provided with a filler neck extending out into the companionway and a sight gauge which shows the fluid level in the reservoir. The outlet to the engine-driven pumps is on the side of the reservoir so that an emergency supply of fluid, available only to the hand pump, remains below this outlet. The outlet for the hand pump is located at the bottom of the reservoir. The total capacity of the reservoir when it is filled to the top marker on the sight gauge is 8.3 quarts; 6 quarts of this fluid are available to the engine-driven pumps and the remainder, 2.3 quarts, are available only to the hand pump.



operate system in flight with emergency shut off valve <u>closed</u>



HYDRAULIC SYSTEM
DC-3/P AIRPLANE

Pressure Regulator Valve

13. The pressure regulator valve consists of a cylindrical housing which incorporates a spring-loaded piston with a ball-check at the top, which opens or closes the passage to the inside of the plunger chamber, depending on the position of the piston. When there is no pressure in the system, the piston is forced down by the spring and the check ball is seated. Fluid from the hydraulic pump passes through the by-pass line and a check valve to the bottom of the regulator and our into the system, raising the system pressure. The pressure building up in the system, acts on the inside of the piston tending to force it upward against the spring pressure. When the system pressure reaches 875 pounds per square inch, the pressure on the piston over-comes the spring force and the piston moves upward, pushing the ball off its seat. With the passage to the inside of the piston chamber opened by the unseated ball, the fluid from the pump flows into the chamber and out of the outlet on the side to the return line. There is no resistance to flow through this latter passage and the pressure against which the pump must work drops practically to zero. In other words, the pump merely circulates fluid from the reservoir, through the top of the regulator valve and back to the reservoir. The check valve at the bottom of the regulator prevents any reverse flow of fluid from the pressure accumulator and this maintains the 875 pounds pressure initially built up.

14. As the fluid is used up by the operation of any of the hydraulic equipment, the system pressure drops. When it has dropped to 600 pounds per square inch, the force of the spring overcomes the pressure holding up the piston and the ball, allowing them to return to their original position. With the passage in the top of the regulator closed, the fluid is again directed around the regulator and through the check 875 pounds. Thus the regulator valve keeps the hydraulic system pressure between the limits of 600 and 875 pounds per square inch.

Pressure Regulator Relief Valve

15. The relief valve for the pressure regulator is mounted adjacent to the regulator and is connected to a port in the return line and a port in the regulator. Should the pressure regulator become inoperative and the system pressure increase above 1000 plus or minus 50 pounds per square inch, the relief valve will open and allow the excess fluid to return to the reservoir. If it is impossible, on the ground, to raise the pressure in the pressure accumulator to 875 plus or minus 50 pounds by use of the hydraulic hand pump with the by-pass valve open, the pressure regulator, hand pump and connecting lines should be carefully inspected for leaks before flying the airplane. The relief valve may be out of adjustment, allowing the fluid to return to the reservoir before the normal operating pressure is attained, or the relief valve seat may require replacement.

Pressure Accumulator

16. The pressure accumulator is merely a forged aluminum alloy spherical housing divided into two compartments by a synthetic rubber diaphragm. Air is contained in the lower compartment under an initial pressure of 250 pounds per square inch with no fluid in the upper compartment and no pressure in the hydraulic system. As the system pressure builds up above 250 pounds, hydraulic fluid forces the diaphragm down and flows into the upper compartment. When the pressure reaches 875 pounds, the accumulater contains approximately 5 quarts of fluid.

17. The purpose of the accumulator is to furnish a mean of storing energy in the hydraulic system for use when the pumps are inoperative and to furnish a reserve supply of pressure fluid which is instantly available in case fluid is drawn from the pressure system faster than the pump can replenish it. When the landing gear is lowered, the weight of the gear and the air load on the gear caused it to drop rapidly. Without the pressure accumulator, the delivery of the hydraulic pump could not keep pace with the demand of the gear and a vacuum would be drawn somewhere in the system. This would tend to draw air into the system through packing glands, etc. The pressure accumulator prevents this from occuring by immediately discharging its fluid into the system. Then, when the gear is down, the pump merely pumps the reserve fluid back into the pressure accumulator.

Hydraulic Hand Pump

18. The hydraulic hand pump is of the double acting reciprocating type supplying pressure with each stroke of the handle. The pump consists of a piston assemble operating in a steel sleve which is screwed into an aluminum alloy housing. On the upward stroke of the ahdn pump handle, the piston assembly moves forward, forcing the hydraulic fluid in the forward chamber of the pump out through the discharge port into the system and drawing fluid into the aft chamber of the pump. When the handle is pushed down, it moves the piston aft. This causes a ball in the piston assembly to unseat, forcing the fluid from the aft chamber into the forward chamber and out to the system.

Hand Pump By-Pass Valve (Shutt - Off Valve)

19. The hand pump by-pass valve is located at the bottom of the pressure regulator and extends out at approximately the center of the hydraulic control panel. It serves merely to furnish a by-pass around the check valve in the main pressure manifold in the event it is desirable to pump up the pressure accumulator by hand. Such a procedure would be desirable only when the airplane by hand. Such a procedure would be desirable only when the airplane was on the ground and the engines inoperative. In flight, the by-pass valve always remains closed, and, in the event of a pressure failure, the hydraulic units are actuated directly from the hand pump. The valve contains a very small bleed hole through the valve plug for the purpose of relieving any excess pressure built up in the pressure manifold by thermal expansion of fluid in the manifold. This bleed hole is small enough so that it does not affect the operation of the system with the hand pump.

Brake System - Description

20. Two individual systems allow either brake to be applied independently by two brake control units in a single housing. Application of toe pressure on the rudder pedals transfers the force to the rear end of the "Tuning Fork" lever on the brake control valve, rotating it about its hinges and forcing the brake valve piston upward. This action allows fluid under pressure from the main hydraulic system to flow to the brake. When the toe pedal is released, the fluid pressure in the valve, assisted by the spring, forces the mechanism back to the neutral position and relieves the brake pressure through the return line.

21. The parking brake mechanism is merely a lock for the brake mechanism which will hold the brakes in the operated position. To set the parking brake, the brake pedals are depressed the full extent of their travel, and the parking brake control, located on the aft face of the control pedestal is pulled out. The force on the pedals is then removed, leaving the pedals in the operated position with the brakes applied, to release the parking brake, a slight pressure is applied to the brake pedals and a spring releasesthe lock. It is not possible to lock or unlock the brakes on each wheel individually. The brakes on both wheels must be locked or unlocked simultaneously.

Brake Control Valve

22. The brake control valve consists of a cast aluminum alloy housing which contains two piston chambers with pressure inlet and reservoir return ports in common, and separate ports to their respective brakes. A system of levers connects the pistons and brake pedals, adjustment being made for correct operating pressures by high and low pressure screws located underneath the valve.

23. Operation of the brake valve is as follows: Application of toe pressure to a rudder pedal works through a seires of levers causing the corresponding piston and valve operating pin to move upward and raise the ball from its seat, connecting the hydraulic pressure line with the line to the brake. Fluid will flow to the brake line until the pressure in the brake line equals the pressure from the pedal holding the piston up, at which point the piston and pin will be forced down, allowing the ball to seat and relieving the brake drom any further increase in pressure. There is no noticeable lag in this operation.

24. When the pressure on the pedal is released, the piston moves down, and a fixed pin mounted through a slot in the piston unseats the valve operating pin. As soon as the piston and pin are separated, two holes in the piston are uncovered and the fluid flows out the return port and back to the reservoir, relieving the brake pressure.

Landing Gear System

25. The landing gear hydraulic system consists of a control valve, and an actuating strut and a boost cylinder on each gear. When the control valve handle is placed in the UP position, fluid under pressure from the hydraulic system is directed to the bottom of each actuating strut, forcing the piston and piston rod upward and pulling each gear into its respective engine nacelle. This action is assisted by fluid from the UP line flowing into the lower end of the boost cylinder. The return fluid from the top of the strut is directed through the control valve into the return manifold. There is no mechanical means of locking the gear in the retracted position and it must be held by the pressure of the fluid in the lower end of the strut. For this reason, the control valve handle should be kept in the neutral position while in flight. This position of the valve blocks off both lines from the struts, thus keeping the pressure in the strut and holding the gear up.

26. When the control handle is placed in the DOWN position, fluid under pressure is directed to the top of the strut and the bottom is connected to the return manifold. The gear is retarded from dropping too rapidly by suction of air through a small hole in the upper end of the boost cylinder. When the gear is fully extended, the pressure in the top of the actuating strut builds up to the full hydraulic system pressure. A pressure gauge is installed in the landing gear down line which indicates the hydraulic pressure in the top of the strut holding the gear down. The gauge is the forward gauge on the right side of the Flight Compartment adjacent to the First Officer's seat.

27. The landing gear hydraulic system is not provided with a means for compensating for temperature changes in the fluid. Thus, when the airplane is left standing on the ground for an appreciable length of time, the landing gear control valve handle must be kept in the DOWN position. This keeps the landing gear system connected to the pressure and return manifolds and allows the pressure bleed in the hand pump by-pass valve to prevent escessive pressure in the landing gear down line due to temperature changes.

Landing Gear Selector Valve - Description

28. The landing gear selector valve is a rotary type valve which directs fluid pressure to either end or the landing gear actuating cylinders, or the flow to the cylinders may be blocked entirely. When the control valve handle is in the "NEUTRAL" position, both ports to the actuating cylinders are closed. When the handle is moved to the "UP" position, the pressure manifold is connected to the DOWN line. When the handle is moved to the DOWN position, these connections are reversed.

29. The control valve handle operates in a notched quadrant and it is necessary to lift thehandle slightly to move it from one position to the other. The landing gear mechanical latch is connected to the landing gear control valve by a rod, and the catch and shoe mechanism on the control valve is designed to that the landing gear mechanical latch control handle, located on the cockpit floor, must be raised to the "LATCH RAISED" position before the landing gear control valve handle can be moved to the "UP" position. The operation of the landing gear safety latch device is fully described in the Diagram, Page of this Manual.

30. Should the latch control handle be moved to the "LATCH RAISED" position before extending the landing gear, the gear will lower, but it will not latch, since the dog which holds the latch down will not spring into position. If this occurs the dog may be tripped manually by means of a small knob attached to the dog, which is located at the pibot of the landing gear control valve handle. It may also be tripped by moving the control valve handle "UP" slightly which will trip the dog. If this is done the gear may partly retract, but it is not necessary to wait for the gear to completely retract. Return the handle of the "DOWN" position and complete the extension in the normal manner.

Landing Gear Actuating Strut - Description

31. The landing gear actuating strut consists of a chrome molybdenum steel cylinder and a piston assembly. The upper end of the cylinder attaches to the nacelle structure and the lower end of the piston rod attaches to the landing gear upper truss. Fluid is directed to either end of the strut by setting the control valve which causes the piston to move, extending or retracting the landing gear, as is desired.