BEECH AIRCRAFT CORPORATION
TECHNICAL TRAINING CENTER

# HIGH PERFORMANCE AIRPLANES

FAR 61.31(e) - A person holding a private or commercial pilot certificate may not act as pilot in command of an airplane that has more than 200 horsepower, or that has a retractable landing gear, flaps, and a controllable propeller, unless he has received flight instruction from an authorized flight instructor who has certified in his logbook that he is competent to pilot an airplane that has more than 200 horsepower, or that has a retractable landing gear, flaps, and a controllable propeller, as the case may be.

## GLOSSARY

Bootstrapping[2] - An undesirable cycle of turbocharging events causing manifold pressure to ~~drift in~~ an attempt to reach a state of equilibrium. It is not detrimental to engine life.

Cam-Ground Piston[3] - An engine piston ground in such a way that its diameter parallel to the piston pin boss is less than its diameter perpendicular to the boss. When the piston reaches its operating temperature, the difference in mass has caused the piston to expand to a perfect circular form.

Coke[3] - A solid carbon-like residue left by petroleum lubricating oil after the removal of the volatile material by heat.

Cowl Flaps[3] - Movable doors on the air exit of an aircraft engine cowling. The cylinder head temperature may be controlled by varying the amount the flaps are opened.

Critical Altitude[1] - Maximum altitude at which, in standard atmosphere, it is possible to maintain, at a specified rotational speed, a specified power or a specified manifold pressure. Unless otherwise stated, the critical altitude is the maximum altitude at which it is possible to maintain, at the maximum continuous rotational speed, one of the following: 1) The maximum continuous power, in the case of engines for which this power rating is the same at sea level and at the rated altitude. 2) The maximum continuous rated manifold pressure, in the case of engines, the maximum continuous power of which is governed by a constant manifold pressure.

Cylinder Choke[3] - A method of boring the cylinder of an aircraft engine in which the top, that portion affected by the mass of the cylinder head, has a diameter slightly less than that of the main bore of the barrel. A taper is usually 0.003 to 0.005 inch. When the cylinder reaches operating temperature, the mass of the head has caused the bore to be straight throughout its length.

Detonation[4] - The spontaneous combustion of the unburned charge ahead of the flame fronts after ignition of the charge. It is the effect of an abnormal combustion of part of the fuel mixture as compared to normal **combustion**. When detonation occurs, the flame propagation during the initial combustion of the charge is normal until approximately 80 percent of the charge is burning. At this point, the combustion accelerates with great rapidity and the remaining charge is burned almost instantaneously, causing an unusual rapid rise in pressure to the maximum and then a rapid drop in pressure. When detonation occurs, the **mean effective pressure** and, in turn, the power output is reduced. The engine is subjected to mechanical shocks thay may cause serious damage to it. Principle factors contributing to detonation: 1) The antiknock value of a fuel, 2) Cylinder temperature, 3) Induced charge temperature, 4) Mixture ratio, and 5) Intake manifold pressure. It is possible to control detonation by using gasoline of the proper octane rating or antiknock value and by the design of the engine itself, especially the combustion chamber.

Detuning[5] - Caused by a sudden change of forces acting on the crankshaft, resulting in an unnatural movement of the dynamic dampeners, causing them to slam against their mountings. The dampener bushings, pins, and possibly the crankshaft may be damaged. Detuning is a source of crankshaft overstress. Rapid movement of throttles or propeller controls may result in detuning of the crankshaft. Excessive speed, excessive power, high RPM with low manifold pressure and improper feathering are also ways of detuning.

Dynamic Dampener[2] - Crankshafts are balanced for static and dynamic balance. A crankshaft is statically balanced when the weight of the entire assembly is balanced around the axis of rotation. It is dynamically balanced when all the forces created by crankshaft rotation and power impulses are balanced within themselves so little or no vibration is produced when the engine is operating. To minimize vibration during engine operation, dynamic dampeners are incorporated on the crankshaft. The dampeners are mounted on pins running in precision ground bushings as an integral part of the crankshaft. The dampener is merely a pendulum designed to position itself by the inertia forces generated during crankshaft rotation. Vibration is absorbed by the dampener oscillating in a small arc out of time with the frequency of crankshaft vibration.

Hot Spots[6] - Areas of a cylinder with non-uniform passage of heat from the cylinder. Localized hot spots cause unequal stresses in a cylinder. Distortion of a cylinder is the result of these unequal stresses set up within a cylinder. A hot spot may cover only a small area of the cylinder or it may be rather large.

Naturally Aspirated[3] - A reciprocating aircraft engine that is not supercharged, but whose induction air is forced into the cylinders by atmospheric pressure only.

Piston Ring Flutter[6] - High frequency sympathetic vibrations induced by engine and accessories operation. Point pressure (mean effective cylinder pressure acting on the side and back of the piston ring) is one of the main engineering controls over piston ring flutter. Ring flutter occurs when the point pressure is too low to exert enough pressure to hold the rings against the cylinder walls. It is usually the speed of the engine in relation to other conditions that allows the rings to start fluttering. Compression rings, and especially top rings, must be operated with a high enough point pressure that the damping effect of the pressure on the points of the rings against a normally smooth cylinder wall will prevent all flutter within the engine speed range. The damping effect of the point pressure may be modified by the load at which the engine is operating. When the load is decreased, the engine speed at which the rings will flutter is also decreased. Piston rings will eventually break when the engine operating conditions permit ring flutter to start and continue.

Overboost[3] - A condition in which a reciprocating engine has exceeded the maximum manifold pressure allowed by the manufacturer.

Pre-Ignition[4] - Means that combustion takes place within the cylinder before the timed spark jumps across the spark plug terminals. Detonation often leads to pre-ignition.

Thermal Shock[3] - A stress induced into a system or component due to a rapid temperature change.

Turbocharger[3] - An air compressor driven by exhaust gases, which increases the pressure of the air going into the engine through the carburetor or fuel injection system.

[1] FAR Part 1, Definitions and Abbreviations

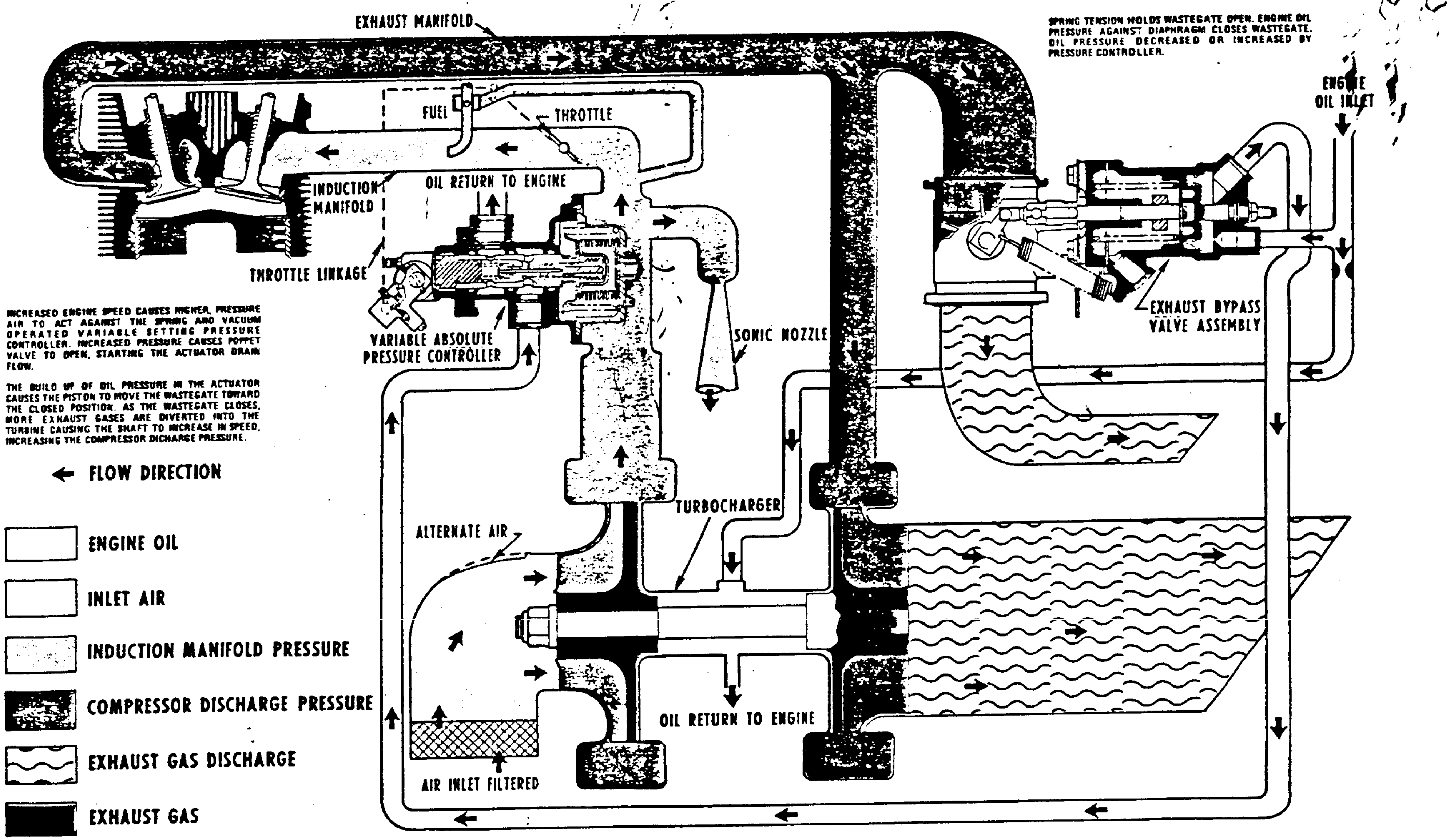
[2] AC65-12A, Airframe and Powerplant Mechanics' Powerplant Handbook

[3] Aviation Maintenance Publishers, Aircraft Technical Dictionary 1st ed.

[4] Aero Publishers, Inc., Baughman's Aviation Dictionary and Reference Guide

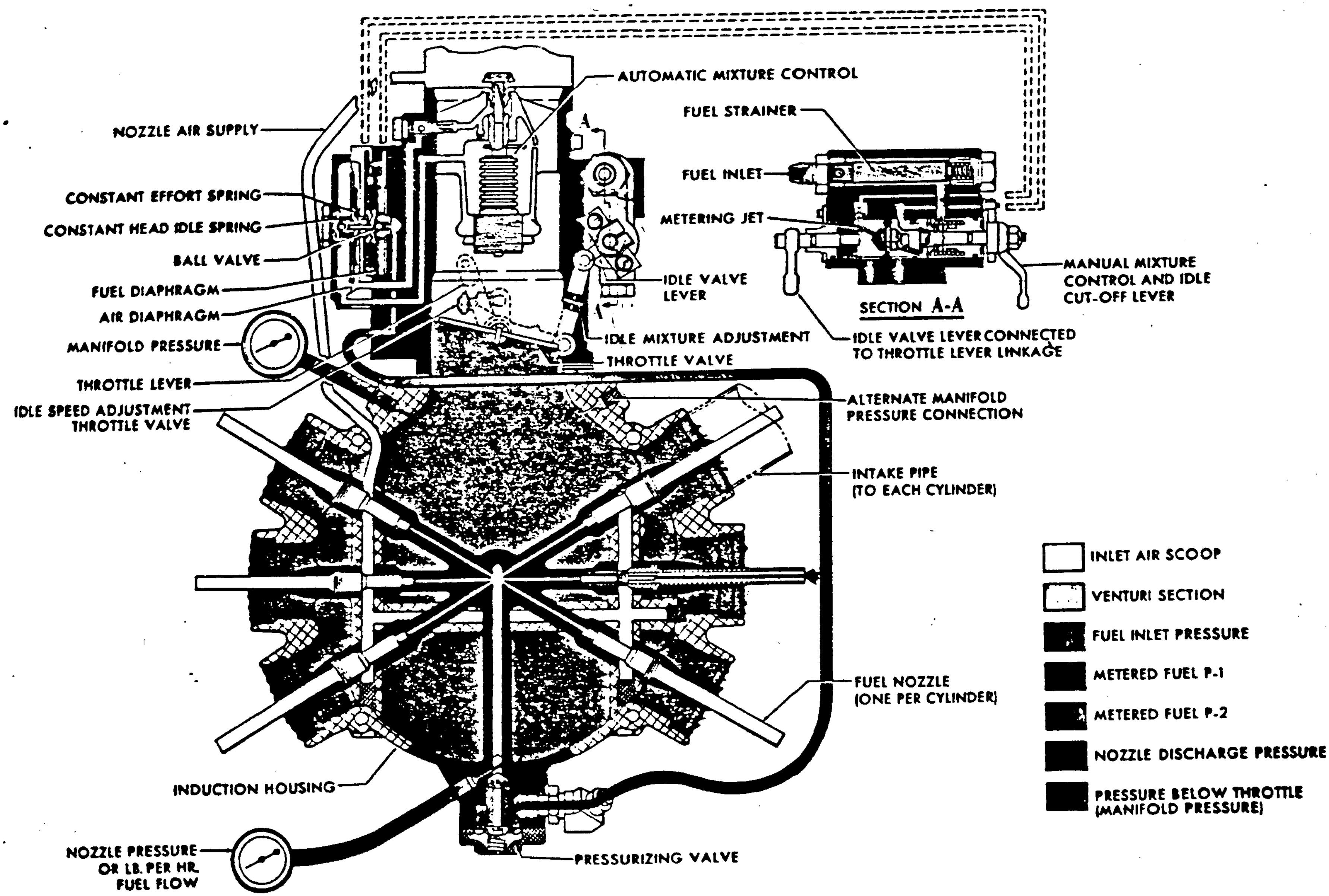
[5] Avco Lycoming, Flyer

[6] Perfect Circle Co., Ltd., Service Manual for the Doctor of Motors



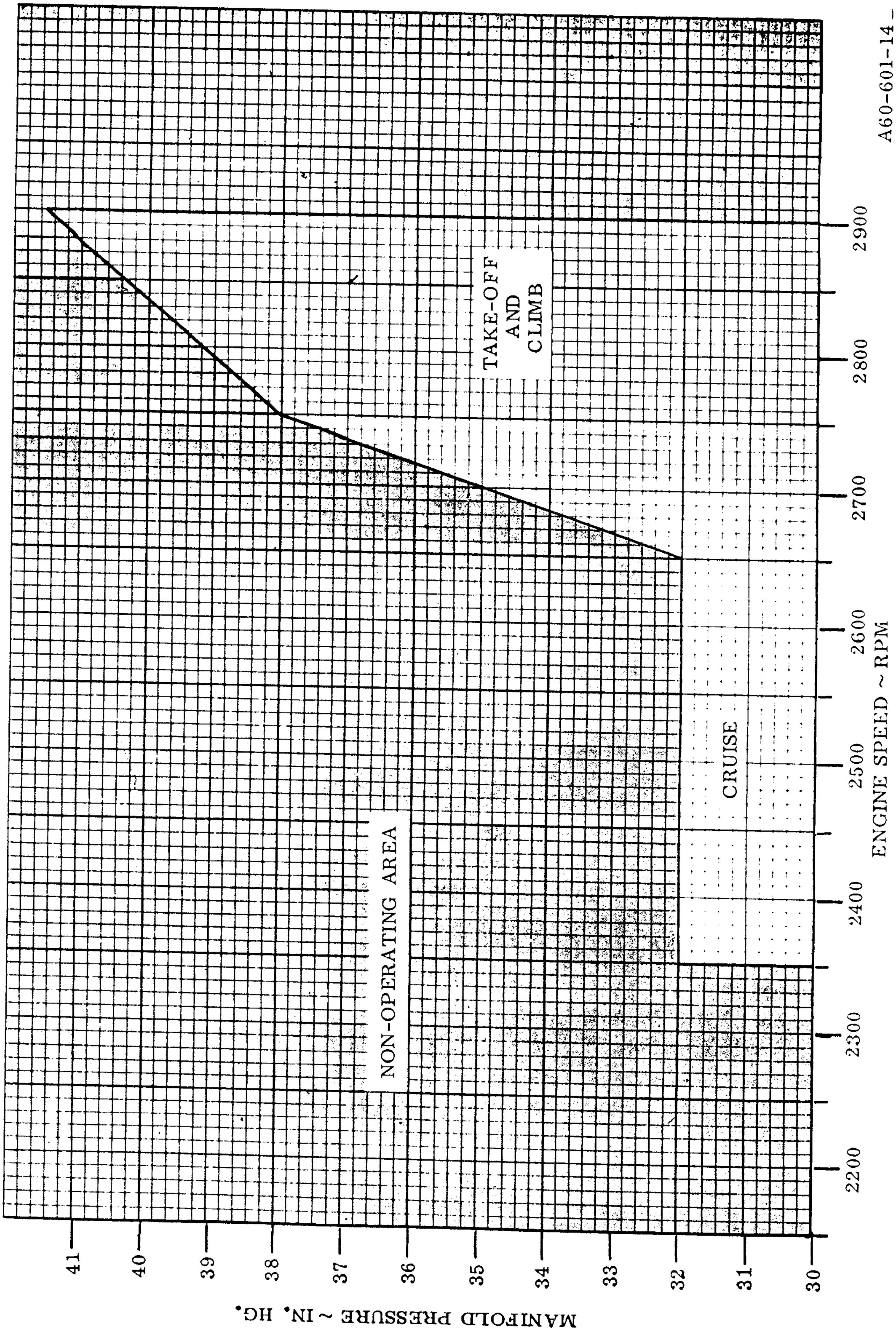

## DUKE 60 TURBOCHARGING SYSTEM

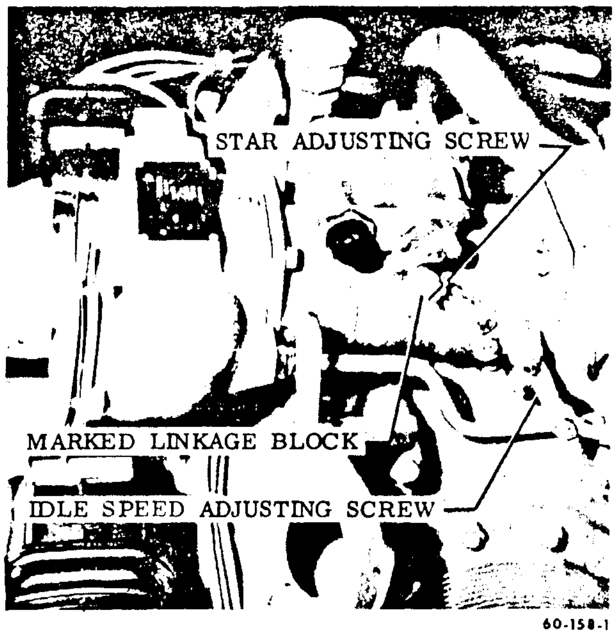
# Schematic Diagram of Avco Lycoming TIO-541-E Series Fuel System Using Bendix RSA-10DB1 Injector



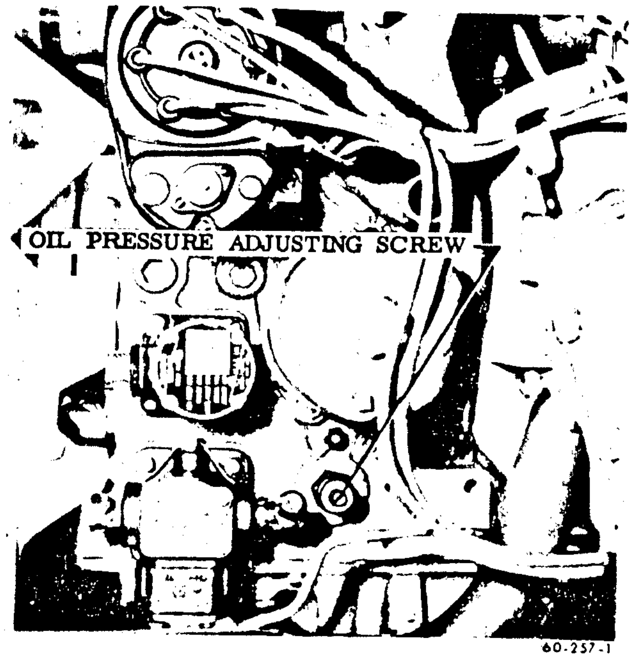

INDUCTION HOUSING

## LIMITING MANIFOLD PRESSURE
### FOR CONTINUOUS OPERATION






Idle and Mixture Adjustment
Figure 201




Oil Pressure Adjustment
Figure 202

## GENERAL - MAINTENANCE PRACTICES

### *TIT INDICATOR CALIBRATION*
(Figure 201)

*CAUTION*

Damage to the turbocharger turbine blades, excessive turbine coking and excessive oil consumption may be caused by turbine inlet temperatures above 900°C (1650°F).

To prevent a turbine inlet over-temperature condition due to an inaccurate TIT indicator reading, the indicator should be checked every 100 hours and calibrated if required.

The following procedure may be used to check and calibrate the TIT indicator.

a. Remove the TIT probe from the turbocharger intake manifold on the RH engine. (Do not disconnect the wires from the probe.)

b. Using the AlCal test equipment, heat the probe to 900°C.

c. If the TIT indicator reads 900°C, the indicator is properly calibrated. If the reading is not 900°C, the calibration screw on the face of the instrument should be adjusted to obtain this reading.

d. If the seal was broken on the calibration screw, reseal by applying a small amount of torque seal as shown in Figure 201.

e. Reinstall the probe in the turbocharger intake manifold.

f. Repeat the above procedure on the LH engine.

### *ALCAL CALIBRATION UNIT*

The AlCal Calibration unit, available locally through the Beechcraft Parts and Service Outlets, provides a simple and accurate method for checking and, if necessary, recalibrating aircraft piston engine EGT systems. If the red line temperature is exceeded by the TIT indicators, the calibration unit will quickly determine if the fault lies with the indication system or the engine. The following method will accomplish the TIT calibration test:

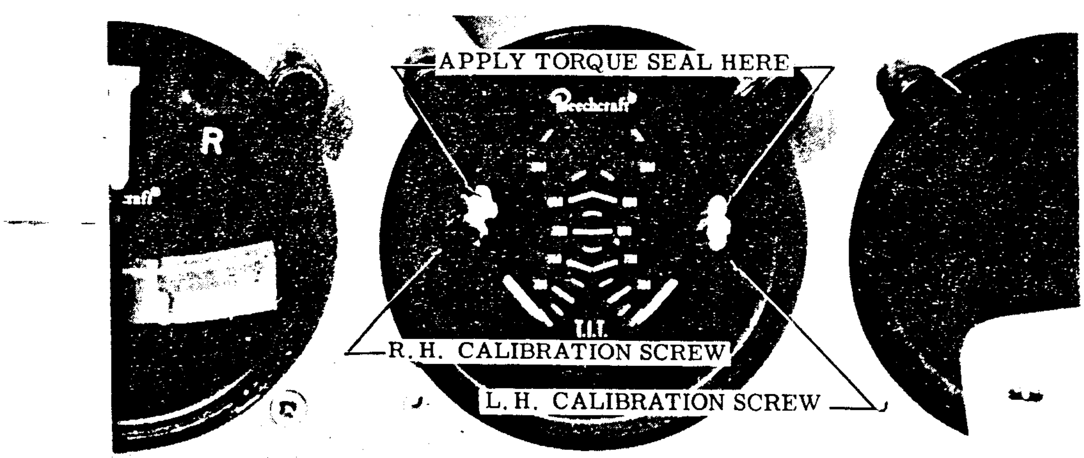
a. Light the AlCal unit and support it from the engine cowling.

b. Place the TIT thermocouple into the comparator port of the AlCal unit until it is touching the reference thermocouple.

c. Raise the heat of the AlCal unit until the temperature of 1650°F (900°C) is indicated on the unit's reference meter.

d. Because both thermocouples are measuring the same temperature, the aircraft-installed TIT indicator should indicate the same red line temperature. If the indicator corresponding to the engine being tested does not register 1650°F (900°C), refer to the adjustment procedure outlined under TIT INDICATOR CALIBRATION in this chapter.

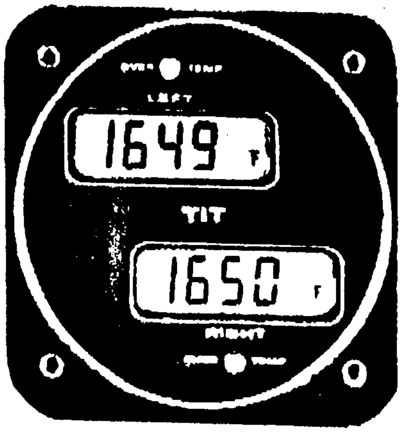
e. Replace the TIT thermocouple in the turbocharger intake manifold. Lubricate the threads on the probe with MIL-A-907D anti-seize compound (Chart 208, 91-00-00).



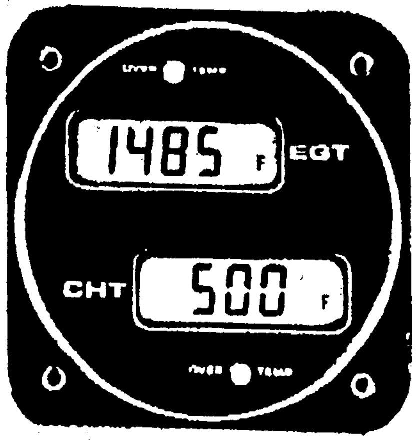

**TIT Indicator Calibration**
**Figure 201**

**"END"**

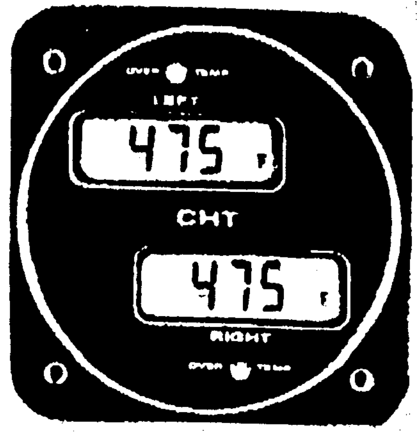
# PRIMARY ENGINE INSTRUMENTS




TT-1P




EC-1P



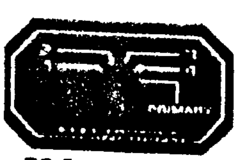

CC-1P

Electronics International's line of primary engine instruments have every FAA approval available (TSO, STC, PMA) and are replacements for those gauges that the FAA has designated as mandatory. These primary gauges are CHT (on all aircraft equipped with cowl flaps) and turbine inlet temperature (TIT) gauges. E.I.'s primary instruments were designed to address the serious problems of over-temping an engine or turbine and those important temperature changes that normally go unnoticed, possibly leading to cracked turbine housings, bent push rods, broken rings, cracked cylinder heads, burnt valves and excessive engine wear. These instruments can be upgraded to full analyzer capability with the addition of our primary remote switch. E.I.'s digital EGT and CHT gauges were the first digital EGT, CHT gauges on the market to receive FAA STC and PMA approval, and our line of primary CHT and TIT gauges are the first digital gauges to receive FAA approval as primary. <u>Only an FAA primary approved gauge can replace the one in your aircraft.</u>

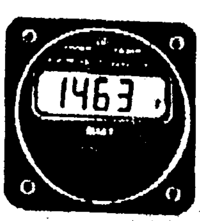
- **OVER TEMPERATURE WARNING LIGHT** — With conventional gauges, an overtemp condition is detected only when the instrument panel is scanned and each gauge's reading is interpreted. This means an overtemp condition could exist for several minutes, causing extensive engine or turbine damage before it is detected. E.I.'s primary instruments have a warning light to give you an immediate and accurate warning to catch your attention before engine or turbine damage can occur. Not only will you fly safer but this could save you thousands of dollars in maintenance costs.

- **RATE AND TREND DETECTION AT A GLANCE** — Most high performance aircraft are flown so close to their temperature limits that temperature changes and their rate and trend are very important to the pilot. E.I.'s unique 1°F display can detect small to relatively large changes (60°F/min.) at a glance. These changes are almost impossible to detect on less accurate gauges. With E.I.'s instruments a pilot can detect and take corrective action to divert a serious problem <u>before an over temperature condition occurs.</u>

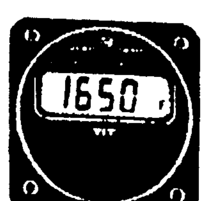
- **EXTREME ACCURACY** — Since most pilots operate at or near temperature limit, instrument accuracy has been a major safety issue with the FAA on primary engine instruments. E.I.'s instruments maintain extreme accuracy and calibration can be verified by the pilot each day by checking for an ambient temperature reading before the engine is started. Therefore, recalibration of the instrument should not be required in its lifetime. The overtemp light and circuitry are also tested each time the instrument is turned on. If a problem develops in the system, an error code will show up in the display. Therefore, you will learn to rely on E.I.'s vital engine instruments with complete confidence.



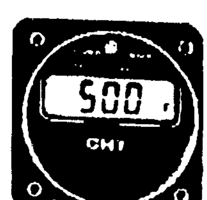

RS-5-1P or RS-5-2P




E-1P



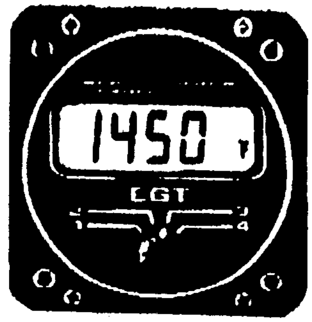

T-1P




C-1P

# ENGINE ANALYSIS MADE EASY


EAC-1




E4

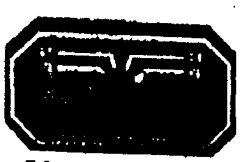
- **MULTI-CHANNEL CAPABILITY** — Many of E.I.'s instruments may be upgraded to a complete EGT and CHT analyzer system by adding one of our small (1"x1"x1¼" depth) remote switches to the system. This means you can have any combination of TIT, EGT, CHT, OAT, Carb Temp, or any other temperature you would like in a single gauge.

- **EASY INSTALLATION** - E.I.'s kits are one of the easiest to install on the market. The instrument, remote switch, probes and cables are all modularly designed with slip-on connectors to make installation fast and easy. Our high input impedance assures few problems with connectors and allows you to use any length cable or you may use your existing type K Thermocouple cables. All wires are color coded and all accessories and detailed instructions come with each kit, making installation a snap.

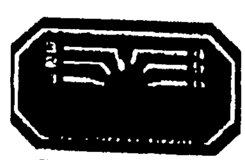
- **APPROVED FOR FAA FLIGHT TESTING** — E.I.'s instruments are used extensively by the FAA for critical flight testing measurements. Each unit is calibrated to NBS and comes with certification paperwork on request.

- **QUALITY AND RELIABILITY SECOND TO NONE** — The quality and reliability of E.I.'s instruments start with design. All units consist of shock-mounted circuit boards in an aluminum extruded case with no moving parts. They draw very little power, develop virtually no heat and operate at a very wide voltage range (7.5 to 35 volts). Our manufacturing plant uses FAA certified inspectors in an environment that was designed to eliminate errors at every stage of the process. Instruments and accessories carry every FAA approval (TSO, PMA and STC) and our reliability record is nothing less than impressive.

- **SUPERIOR SERVICE** — You won't find a company anywhere more service conscious than Electronics International. We stand behind our products 100% and offer a one-year (unlimited hours) warranty on all instruments and accessories. All prices are "kit" prices, with no additional costs added for probes or cables. When you purchase an E.I. instrument, you're also purchasing unbeatable service, reliability and quality.



RS-4-1 or RS-4-2



RS-6-1 or RS-6-2

# AVCO LYCOMING DIVISION

WILLIAMSPORT, PENNSYLVANIA 17701

# Service Bulletin

L

DATE: June 20, 1980

**Service Bulletin No. 245C**
**(Supersedes Service Bulletin No. 245B)**
**Engineering Aspects are**
**FAA (DER) Approved**

SUBJECT: **Fixed Wing Aircraft Operational Precautions Necessary to Avoid Engine Damage Due to Detuning the Dynamic Counterweight System.**

MODELS AFFECTED: 0-360-A1F6, -A1F6D, -A1G6, -A1G6D, -E1A6D, -F1A6; LO-360-A1G6D, -E1A6D; IO-360-A1B6, -A1B6D, -A1D6, -A3B6D, -C1C6, -C1D6, -C1E6; AEIO-360-A1B6, -B1G6; LIO-360-C1E6; TIO-360-A3B6; TO-360-C1A6D, -E1A6D; LTO-360-E1A6D; GO-435-C2, -C2A, -C2A2, -C2B, -C2B1, -C2B2, -C2C, -C2E, -C2C6, -C2D6, -C2E, -C2B2-6; GO-480-B, -B1A6, -B1B, -B1C, -B1D, -C1B6, -C1D6, -C2C6, -C2D6, -D1A, -F1A6, -F2A6, -F6, -G1A6, -G1B6, -G1D6, -G1J6, -G2D6; IGO-480-A1B6; GSO-480-B1A6, -B1B6, -B1C6, -B1J6, -B2D6; IGSO-480-A1A6, -A1B6, -A1C6, -A1E6, -A1F6; 0-540-A1A, -A1A5, -A1B5, -A1C5, -A1D, -A1D5, -A2B, -A3D5, -A4D5, -B1A5, -B1B5, -B2B5, -B2C5, -B4B5, -E4A5, -E4B5, -E4C5, -F1A5, -G1A5, -G2A5, -H1B5D, -H2B5D, -J1A5D, -J3A5D, -J3C5D, -L3C5D; IO-540-A1A5, -B1A5, -C1B5, -C4B5, -D4A5, -E1A5, -E1B5, -G1A5, -G1B5, -G1C5, -G1D5, -G1E5, -G1F5, -J4A5, -K1A5, -K1A5D, -K1B5, -K1C5, -K1D5, -K1E5, -K1F5, -K1F5D, -K1G5, -K1G5D, -K1J5, -K1J5D, -L1A5, -M1A5, -M1A5D, -M1B5D, -N1A5, -P1A5, -R1A5, -S1A5, -T4A5D, -T4B5D; AEIO-540-D4A5, -D4B5, -L1B5D; TIO-540-A1A, -A1B, -A2A, -A2B, -A2C, -C1A, -G1A, -H1A, -F2BD, -J2BD, -N2BD, -R2AD, -S1AD; LTIO-540-F2BD, -J2BD, -N2BD; IGO-540-A1A, -A1C, -B1A, -B1C; IGSO-540-A1A, -A1C, -A1D, -A1E, -A1H, -B1A; VO-540-B1B3, -C1C3; TIO-541-A1A, -E1A4, -E1B4, -E1C4, -E1D4; TIGO-541-B1A, -D1A, -D1B, -E1A; IO-720-A1A, -A1B, -B1B, -B1BD, -C1B, -D1B, -D1CD.

TIME OF COMPLIANCE: **At all times during engine operation including ground running.**

**In the counterweight system, the inertia forces of the engine (which increase with engine speed) are counteracted by the expansion forces acting on the pistons. Therefore, the loads imposed on the engine parts are represented by the difference between the two forces. Thus, at high speeds where the inertia forces are the greatest, the resultant forces are much higher with low manifold pressure than with high manifold pressure, cylinder pressure being in direct proportion to manifold pressure. When one of these two forces, the inertia force or the expansion forces, are suddenly changed, the elimination of one of these forces can cause the counterweight system to detune.**

Detuning the counterweight system of the engine can occur when the engine operates outside of its normal range and by abrupt throttle change. When this happens the dynamic counterweights can not follow the spectrum of frequencies for which they were designed and rapid and severe damage to the counterweights, rollers and bushings result; culminating in engine failure.

Essentially, there are four operating conditions that can cause the counterweight system to detune; they are as follows: -

1. RAPID THROTTLE OPERATION: - Rapid opening or closing of the throttle can cause counterweight detuning. This can occur while adjusting the governors or other checks on the engine which make it necessary to run the engine at rated take-off speed. Also, detuning can occur if the power is suddenly cut-off, such as during a simulated engine failure as required for pilot training. To avoid this, use the mixture control to shut off the engine and leave the throttle in normal open position until the engine has slowed down because of lack of fuel. Then close the throttle to a zero thrust condition. The throttle being open allows the cylinder to fill with air, maintaining the normal compression forces which are sufficient to cushion the deceleration of the engine. Another result of rapid throttle movement is severe strain on the supercharger gears and associated gears because of the inertia force of the high speed impeller.

2. HIGH ENGINE SPEED AND LOW MANIFOLD PRESSURE: - Any operating procedure involving high R.P.M. engine speed and low manifold pressure (under 15 inches Hg.), such as might be the case during a power-off descent, can cause detuning of the dynamic counterweight system. However, just prior to touchdown, during the landing sequence it is permissible to place the propeller governor control in the high R.P.M. (low pitch) position and the throttle control may be closed. At this low airspeed there will be no increase in engine R.P.M.

3. EXCESSIVE SPEED AND POWER: - Any supercharged or turbocharged engine, without automatic manifold pressure controllers, has the inherent capability of operating at power settings beyond the capability of the engine; this is particularly true at low altitude. See the operators manual for speed and power limitations for specific engine models.

4. PROPELLER FEATHERING: - Avoid propeller feathering during flight. If practice feathering must be accomplished be sure the throttle of the feathered engine is set at approximate zero thrust position before mixture control is opened and engine operation resumed. See the aircraft operation manual for specific feathering instructions.

NOTE: Revision "C" changes Models Affected and revises text.

AVCO LYCOMING DIVISION
WILLIAMSPORT, PENNSYLVANIA 17701

# Service Bulletin

(L)

**DATE:** September 20, 1985

Service Bulletin No. 471
Engineering Aspects are
FAA Approved

**SUBJECT:** Avco Lycoming Oil Additive P/N LW-16702

**MODELS AFFECTED:** TIO/TIGO 541 Series Engines

**TIME OF COMPLIANCE:** At initial oil fill and every oil change thereafter, or at every 50 hours, whichever occurs first.

Avco Lycoming considers use of Oil Additive P/N LW-16702 to be essential in TIO/TIGO-541 series engines.

Original approval of the oil additive was released in 1981 to the field in the form of a Service Instruction. We believe that some operators may not realize the importance of the use of this additive.

The additive contains an anti-scuffing agent. Laboratory tests indicate that occasionally when an engine is first started, particularly if the engine has not been used for an extended period, or during cold weather, for a very brief interval there is insufficient residual oil between moving parts; this can reduce the service life of components. The additive helps to maintain a film of lubricant to help protect the engine during the initial start-up.

The additive must be consistently used, with additive added at each oil change. A period of non-use can initiate distress which will not be cured by later use of the additive. Its use is essential in new, remanufactured and overhauled engines.

The following amounts of LW-16702 should be used:

Two (2) 6 ounce cans for a 12 - 15 quart sump

Three (3) 6 ounce cans for a 17 - 19 quart sump.

Four (4) 6 ounce cans for a 23 quart sump.

This oil additive may be purchased from your local FBO or nearest Avco Lycoming distributor.

NOTE

If it is determined that a FAA approved lubricating oil being used contains, in the proper amount, an oil additive equivalent to LW-16702, the provisions of this Service Bulletin are being met.

AVCO LYCOMING WILLIAMSPORT DIVISION
AVCO CORPORATION
WILLIAMSPORT, PENNSYLVANIA 17701

# Service Instruction

L

DATE: November 23, 1984

Service Instruction No. 1409A
(Supersedes Service Instuuction No. 1409)
Engineering Aspects are
FAA Approved

SUBJECT: Avco Lycoming LW-16702 Oil Additive.

MODELS AFFECTED: All Avco Lycoming piston aircraft engines.

TIME OF COMPLIANCE: At initial oil fill and every oil change thereafter, or at every 50 hours, whichever occurs first.

Avco Lycoming has approved an oil additive LW-16702 that has an anti-scuffing agent. This characteristic serves to reduce wear. For engines already in service, the use of the additive may be started at the next oil change. Use oil additive, as shown in the following chart.

Use (one) 6 ounce can (LW-16702) per 6 - 8 quart sump.
Use (two) 6 ounce cans (LW-16702) per 12 - 15 quart sump.
Use (three) 6 ounce cans (LW-16702) per 17 - 19 quart sump.
Use (four) 6 ounce cans (LW-16702) per 23 quart sump.

This oil additive may be purchased from your Avco Lycoming distributor.

NOTE

"If it is determined that a FAA approved lubricating oil being used contains, in the proper amount, an oil additive equivalent to LW-16702, the provisions of this Service Instruction are being met."

NOTE: Revision "A" adds NOTE recognizing FAA-approved oils that contain an additive equivalent to Avco Lycoming oil additive, LW-16702.

21530, 21530A - This number for Avco Lycoming reference only.

# TROUBLE-SHOOTING THE BENDIX

## RSA FUEL INJECTOR

There are some sections of the Bendix fuel injector that a mechanic may not work on in the field, such as regulator section which consists of the air and fuel diaphragm and associated parts. Any Modification of the regulator section by a mechanic without the use of a flow bench could result in a change in fuel flow through the injector, so—hands off in this section please. However, there are some things that a mechanic may do that will not affect the operation of the fuel injector.

In the following paragraphs we would like to discuss some of the things that a mechanic can do, and some procedures a mechanic can use to determine if the problem is in the fuel injector or an associated part, i.e. - fuel nozzles, fuel lines, etc.

Whenever a fuel injector problem arises, the first thing a mechanic should do before he removes the injector or any part of it, is to make sure the rigging is correct, and that the throttle and mixture control are both traveling to their full open and full closed stops; and make sure there are no fuel leaks. Another important item to consider is - do you get a rise of 25 to 50 RPM at idle when the mixture control is moved from full rich to idle cutoff. If you are experiencing poor acceleration of the engine, this may be your problem. To adjust the idle mixture, turn the scalloped wheel at the side of the injector either rich or lean, as required, until the desired rise in RPM is reached. When adjusting the idle mixture, you will no doubt have to adjust the idle RPM too. A good idle RPM is around 600 to 650 RPM.

We would like to make everyone aware of the fact that there is a filter screen at the fuel inlet of the injector. This screen should be removed and cleaned at each 100 hr. inspection. Some cleaning solvents that can be used are M.E.K., or acetone. It is also permissible to use a sonic cleaner. After the screen has been cleaned, blow it out with compressed air. When removing the screen from the fuel injector, always take it from the same side of the injector to which the fuel line is attached. This is to prevent depositing any dirt back in the fuel injector that might have been picked up in the screen. On early injectors, the screen is attached to the inlet adapter, so it can only be removed from that side. On later model injectors the screen is spring loaded to provide a fuel by-pass in case it becomes plugged. This type of screen could be removed from either side.

If you are experiencing a rough shut-down and the engine doesn't want to quit when the mixture control is retarded, it may be because there is a score on either the mixture control jet or rotation plate, or a bad "O" ring on the jet. Prior to disassembly of the fuel injector, a test can be run to see if this is the problem area. Disconnect the fuel line coming out of the fuel injector and leave the fitting open. Pull the mixture control and throttle all the way back (off) and turn on the booster pump. If any fuel is observed coming out of the open fitting, you have a score on the mixture control jet, or rotating plate, or the "O" ring is damaged or deformed. The repair is to remove the mixture control assembly and eliminate the scores by lapping the mixture control jet and rotating plate on a good lap plate using a mild abrasive. The final repair should be done by lapping the jet and plate together, using Bon-Ami or equivalent type abrasive. After this is accomplished, clean and re-assemble the parts using a new "O" ring each time.

If no fuel is observed coming out of the open fitting on the injector when the test is performed, the mixture control assembly is working correctly and you should look in other areas for your problem. Some things to consider are the fuel injector nozzles. If the air bleed hold becomes plugged, the engine will not shut down smoothly. On normally aspirated engines, there is a screen covering the air bleed hold which makes a visual inspection impossible. Therefore, you must remove the nozzles from the engine and clean them thoroughly and blow them out with compressed air. If this does not do the job, you may have a nozzle that is improperly assembled, or you were unable to remove the dirt, and the only solution is to replace the nozzles.

On turbocharged engines, the air bleed holes is shrouded and vented back to the compressor discharge pressure "deck pressure". Inspect these lines and fittings to make sure they are free of dirt, leaks, or obstructions. After the shroud is removed from the nozzle, it can be removed from the cylinder, cleaned thoroughly and blown out with compressed air. NOTE: When any nozzle that is installed horizontally is reassembled into a cylinder, make sure that the letter "A" that is stamped on the hex portion of the nozzle is pointing down, this positions the air bleed hole up, and the correct torque valve is applied at 60" lbs.

Another area to consider would be an internal leak in the fuel injector center body seal. All of the fuel that is delivered to the engine should go through the individual fuel lines to the nozzles and on into the combustion chamber. If there is an internal leak in the injector, there will also be fuel entering the injector at the throat, and going to the cylinders much like a carburated engine. If you suspect a center body seal leaking, there is a brief test you can run to determine if you are right or wrong. First, remove enough of the induction system to enable you to see the impact tubes on the fuel injector. Then disconnect the fuel line from the fuel injector to the flow divider and cap off the fitting in the fuel injector. Move the controls to the full throttle and full rich position and turn on the booster pump. If any fuel is observed coming out of the injector, this indicates that there is a center body seal leaking. Since this is part of the regulator system the mechanic may not make the necessary repairs, but must remove the injector from the engine and send it to an overhaul facility for reconditioning and recalibration.

In addition to a rough shut-down, the engine may display some other symptoms that may indicate that there is a center body seal leak. Some of these indicators are:

The engine is rich at idle and low power settings, or the pilot has to retard the mixture control upon flare-out and landing to prevent the engine from becoming too rich and stopping, or if the mechanic has to adjust the idle mixture lean every few days or weeks because it has drifted rich. Each of these symptoms indicate a drift to the rich side and may be warning you of an internal leak in your injector.

Another area where problems may be encountered in the fuel injector is the possibility of scores on the main meter jet and rotating plate assembly. Any scores in this area may be removed by lapping the main meter jet and rotating plate on a good lap plate using a mild abrasive. The final repair should be made by lapping the jet and plate together. When all scores are removed, clean thoroughly and reassemble the injector. An indication that the main meter jet is scored would be a rich idle mixture, and by adjusting the mixture control lean, the mechanic could get a satisfactory idle, but when the engine was accelerated, it would stumble and not accelerate smoothly.

If there is any occasion when the fuel injector idle mixture adjusting wheel has been turned to its limit, either rich or lean, and the idle is not satisfactory, the linkage between the air valve and the fuel valve on the injector may be removed and the idle mixture adjusting wheel positioned back to the center of its travel. Prior to removing the linkgae from the injector, measure the overall length of the linkage. This must be the same after repositioning the wheel back on center as it was before removing it from the injector. After the length of the linkage has been established, adjust the wheel back to center of travel by backing one end of the linkage assembly out half the distance and adjusting the other end of the linkage in until you come up with the same overall length you had prior to removing it from the injector. After the linkage is adjusted, assemble the injector, making sure to install the pins, wave washers and cotter keys correctly.

If the fuel flow gage suddenly shows an increase in flow, the first thing to do is check for a plugged or partially plugged fuel nozzle. The procedure for doing this is as follows:

Disconnect the fuel lines and remove the nozzles from the cylinders. Then attach the nozzles to the fuel lines and direct the nozzles into bottles of equal size. Baby food jar or coke bottles work very well. Move the throttle and mixture controls full forward and turn on the booster pump. Fill the bottles approximately one-half full. Turn off the booster pump and retard the throttle and mixture. Remove the bottles from the engine and set them on a table or other flat surface. A visual check of the fuel contents in the bottles will tell you which nozzle is plugged. NOTE: (While flowing fuel into the bottles, check each nozzle to make sure all of the fuel is coming out of the discharger end of the nozzle in a solid stream approximately the size of the lead in a mechanical pencil and not some fuel coming out of the air bleed hole). After locating the plugged nozzle, it can be cleaned in M.E.K. or acetone and blown out with compressed air. If a thorough cleaning fails to remove the dirt, the nozzle will have to be replaced. Prior to replacing the nozzle, check the fuel line to be sure someone didn't use a primer line for a fuel line. Primer lines are smaller on the inside diameter, and will give a false reading on the fuel flow gage. Also check the flow divider for obstructions. NOTE: When cleaning fuel nozzles, fuel lines or flow dividers, *never* use a small drill or a piece of wire.