enstone
FLYING CLUB

An Introduction to Complex Aircraft Operation

Variable pitch propeller

The main difference between a simple TB9 and the TB10/200 is the use of a propeller control and manifold pressure to set power. The Variable pitch propeller can also be called a constant speed propeller, since the propeller lever controls the engine RPM at the normal cruise power settings. Once this RPM is set, the prop will continually rotate at this constant speed.

The throttle controls manifold pressure (MP) and (indirectly) pitch of the prop. Increasing throttle increases the manifold pressure (the pressure of the air/fuel mixture going to the engine) and the prop tries to turn faster. The prop controller then resists faster RPM by increasing the "bite" of the blades in the air. This increased pitch and angle of attack of the blades causes more thrust, but also causes more drag, resisting an increase in RPM. In a sense, throttle only increases the torque of the engine, and then the prop governor increases the pitch of the blades to produce more thrust and drag. This happens quickly and automatically, so no change in RPM is noticed.
So, the throttle controls the MP/engine torque/prop pitch, and the prop lever regulates engine/prop RPM.

Many modern high-performance aircraft are very noisy on takeoff and landing. Experienced pilots mitigate this problem by avoiding high RPM conditions whenever possible. At high RPM on takeoff or in preparation for landing, the prop tips may reach supersonic speeds, causing quite a bit of noise and inefficiency. Some airplane owners replace their two-bladed props with three blades to reduce noise and increase efficiency, since each of the three blades now has an angle-of-attack which is less than for the two-bladed prop. (We don't anticipate that our TB20 is in imminent danger of having a 3 bladed prop, they are expensive.)

In Review of the Variable Pitch Propeller:

- the RPM control sets prop/engine RPM
- the throttle controls manifold pressure, and indirectly controls prop pitch (through the action of the prop governor)
- unlike a fixed-pitch prop, constant speed props produce max RPM/power for takeoff
- loss of oil pressure causes flat pitch (high RPM)
- lower cruise RPM causes less noise, smoother through turbulence
- prop oil thickens at low temperatures, alter the prop control every 15 min
- idle throttle causes flat pitch, high drag "plate" airbrake
- higher MP with same RPM causes more torque (and p-factor)

Engine Management

A complexity of high performance engines is power management. A TB9 has a low power, four-cylinder engine, with excellent airflow providing cooling to all four loosly cowled cylinders. A TB10/200, on the other hand, has a larger, more powerful engine with somewhat poor airflow. Dramatic changes in power cause the cylinders to cool much more quickly than normal. This uneven cooling may cause the cylinders to warp or crack. This phenomenon is called "shock cooling."

After takeoff, at 1000 AGL, lower the nose and reduce power to cruise climb for cooling. Leveling off for cruise the engine is kept fairly warm during this whole period, shock cooling is less likely in these stages. Shock cooling is most prevalent in the descent for landing. An inexperienced pilot, at high cruise may initiate a descent for landing by pulling power to idle, richening the mixture, and itching the nose down for a fast descent. The engine at low power produces much less heat, the rich mixture provides an excess of fuel to cool the cylinders, and the increased airspeed and airflow further cools the engine quickly.

If a cylinder head temperature (CHT) and exhaust gas temperature (EGT) gauge is installed, the CHT will dramatically drop and the EGT will read negligibly. The owner of this airplane will need new "jugs" (cylinders) much sooner than the rated time between overhauls (TBO). Instead, the experienced high-performance airplane pilot will manage the cooling of the engine by slowly, evenly reducing the cylinder temperatures. The pilot plans for the descent much further away from the destination, planning for a 300 ft/NM descent, starting the descent from cruise at 10,000 feet and 30 NM from the destination. The pilot pitches down in a gradual descent, which slightly increases airspeed and cooling.

The pilot then starts a very gradual power reduction, reducing MP by 1" per minute (some owners do 2" per 2 minutes). As the power is reduced, the engine cools gradually, but the airspeed also slows slightly. This lower airspeed reduces airflow and slightly warms the engine.
The pilot approaches the pattern entry point somewhere around 16" to 18"MP. He may be too fast for the pattern. Instead of reducing the power further, the pilot may drop the gear, or use flaps to increase descent or slow the airspeed when power reductions would otherwise shock cool the engine.

The pilot is now abeam the numbers or on final, at the correct airspeed. Following the checklist, the mixture is set full rich and the prop is set at high RPM in preparation for the go-around. By waiting until the plane was slowed and the power was 15" to 17" before setting the prop, he didn't have a noisy, high RPM prop in this low pattern. As the prop goes forward, the MP drops another inch to 14".

Now the pilot is still a little too high for landing. Instead of pulling power off (far below the RPM green arc), he increases the flap setting to increase the descent rate. He then sets up for landing with 30 flaps and 12” MP. The lower airspeed on final keeps the engine warmer as the MP is reduced.

Finally, after landing the pilot taxis smoothly off the runway and raises the flaps. The pilot taxis slowly to the ramp, and shuts down.

In Review of Engine Management:

- plan 300ft/NM descents, 10K AGL/30 NM, 1000 AGL/3 NM
- pitch down to start descent
- gradually decrease MP, 1" per minute or 2" every two minutes
- if ATC requests descent consider using gear/flaps
- use CHT/EGT/oil temp gauges to monitor engine cylinders