Lesson 1: Complex Aircraft Checkout

Fly This Lesson Now

by Rod Machado

Congratulations on completing the student and instrument private pilot lessons. You've come this far and you should feel quite proud of yourself. I'm certainly proud of you. Now it's time to make another big jump in your aviation education. The three commercial lessons and solo session in this series will help prepare you to operate heavy machinery. No, I don't mean bulldozers, backhoes, and street cleaners; I mean an airplane like the twin-engine Beechcraft Baron 58.

Whether or not you know it, I have big plans for you. That's why I picked the Beechcraft Baron 58 for your commercial training. I eventually see you flying heavy metal, and I don't mean rock bands, either. Without having to consult a psychic, I think there is a Boeing 737–400 in your future. That's the heavy metal of which I speak. If one of these airplanes is in your stars (or possibly your airport garage), then it's best that you know how to operate an airplane with complexity somewhere between that of a Cessna Skyhawk SP Model 172 and the Boeing 737. That's why I won't put you directly into a Boeing 737 for your commercial training. If I did, you'd probably spend all your time saying things like, "Yeee haaa!, hold on little doggie, whoooa boy, whoooa boy, somebody stop me!" You get the point, right? It's just too big a jump without first taking an intermediate form of training.

There's one thing, however, that won't happen with the commercial training in the Baron. Because of the difficulties involved, we won't be practicing any single-engine operations in this multiengine airplane. If you want to fly on a single engine, I have a Skyhawk SP ready and warmed up for you. It's true, however, that the most important thing about learning to fly a multiengine airplane is dealing with the loss of one engine. (By that I mean one engine stops running at a very critical time, not that we actually lose an engine like we do with a set of car keys.) Anyone who flies an actual multiengine airplane is sure to practice single-engine operations. For our purposes, we'll assume that both engines on the Baron operate at the same time, all the time, which is how it works in real life 99.999999 percent of the time. That's why we won't be discussing things like single-engine minimum control speed, also known as Vmc, as well as Vsse, Vyse, and so on. As a benefit, all the material discussed in this lesson is applicable to the operation of any complex single-engine airplane, too. If you want to learn more about engine-out procedures in twin-engine aircraft, see **Flying Twin-Engine Aircraft** in the Learning Center.

I do feel obligated to offer one more note for those who actually fly the Baron outside of Flight Simulator: I've had to modify the operating procedures slightly to make these lessons work. That's why you should always check the actual airplane's Pilot Operating Handbook for the specific procedures applicable to the airplane you fly. And whatever you do, don't run with a pair of scissors in your hand or jump into a swimming pool until an hour after you've eaten. You get the point, right?

And so we begin.

Complex Airplane: The Big Picture

First, here's an easy question. Why do they call them the Canary Islands? Good, you got that one. Now, why do we call the Beechcraft Baron a complex airplane? If you've never been in one, the Baron can appear quite complex, especially if the only airplane you've flown is the Skyhawk SP.

Complex airplanes always have three things in common: flaps, retractable gear, and a controllable propeller. You're already familiar with flaps since you used them on the Skyhawk SP. Before we begin our in-depth study of the Baron, let's take a quick look at its instrument panel to make sure we know what we're looking at.

Figure 1-1 is a picture of the Baron's instrument panel with its major instruments identified below. Study this carefully and familiarize yourself with these instruments. Once done, you can begin your lesson.

Figure 1-1 A-Propeller Controls B-Fuel Selector C-Cowl Flaps D-Manifold Pressure E-Propeller RPM F-Landing Gear G-Flaps

Retractable Landing Gear

Long ago, someone decided that retracting the airplane's gear would reduce drag and allow the airplane to fly faster. Not only does this work in theory, it also works in practice. Airplanes can fly, climb, and descend at a faster speed with the gear retracted. These same airplanes can also slow down faster when the gear is extended. Pilots often use landing gear drag to their advantage to help them get the airplane down quicker when they are in the vicinity of the airport in preparation for landing. Although there are a few important items to remember about operating the gear, nothing is more important than remembering to put it down before landing. You don't want to land your airplane with the gear retracted. You'll know if you did because it will take full power to taxi the airplane. Just kidding, but you get the point, right?

Figure 1-2

Figure 1-2 shows the Baron's gear handle next to three green lights, each representing one of the three landing gear struts. The center green light represents the nose gear; the two green lights on either side represent the right and left main gear. After takeoff, once the VSI shows a positive rate of climb, you should raise the gear handle to retract the gear. At this point, you'll want to check to make sure that all three green lights go out, indicating that each gear has retracted (Figure 1-3).

Figure 1-3

It's a good procedure to say "Gear up and locked" after raising the gear handle and all three gear lights show proper gear retraction. If the gear failed to retract (or extend, for that matter) the **gear in transition** light might remain illuminated. Sometimes, albeit rarely, this does happen. While mechanical equipment is reliable, it's not completely reliable. That's why, as I write this, I keep two computer repair kits handy in case a circuit board goes haywire. If one or more of the gears didn't retract, then, as the astronauts say, "Houston, we have a problem." You'd want to lower the gear handle and return for landing to have your machine checked out by a qualified mechanic.

Fortunately, landing gear is very reliable. In fact, whenever there is a problem with the gear it's usually pilot induced. For instance, you shouldn't lower the gear while flying at speeds above 152 knots. Doing so exposes the gear doors to extreme stress, possibly causing them to leave the airplane. This isn't good, even if you don't own the airplane. So make sure you slow the airplane down to 152 knots or less before you lower the gear.

If you're in cruise flight zipping through the air at 170 knots indicated airspeed, you'll have to reduce power to slow the airplane down. In an actual airplane, you wouldn't want to yank the throttle back to idle to do this, either. Yanking a throttle is never a good idea in an airplane. Doing so, according to many experts, could shock-cool the engine. Think of this as installing a large glacier under your engine cowling when it's at its peak operating temperatures. Making this behavior a habit might result in long term engine damage. That, my friend, is no good. (It's also why in the very next section I'll talk about how to use something known as cowl flaps to keep your engine from overcooling and overheating. Stay tuned, future power plant master.)

So, plan in advance and gradually reduce power to slow the airplane down before lowering the gear. In case you're wondering, the professionals try and reduce power no more than one inch of manifold pressure per minute (you'll learn about manifold pressure shortly).

One last thing about landing gear operations. As I've already mentioned, you must remember to put it down before you land. If you don't, then you won't need your landing light to see the runway at night. The sparks from the airplane's metal belly will light the runway for you.

While most airplanes have a warning horn (or a warning instructor) to remind you to put the gear down before you land, I like to count proper planning to accomplish this objective. That's why you'll always use the acronym GUMP before every landing.

GUMP reminds you to check

Gas: Make sure you're operating on the fullest fuel tank.

Undercarriage: See that you've place the gear handle down and that you see three green gear lights.

Mixture; Verify that the mixtures are full forward.

Prop: Ensure that the propeller levers are in their full forward position. (We'll talk more about this later).

I always say "GUMP" at least four times before I land any retractable-geared airplane to remind me to put the gear down. You should, too. But don't mispronounce this: It sounds a lot like like "jump," and you don't want your passengers to do that.

I say GUMP on the downwind leg (the gear should be down by then), on base leg, on final and when I cross the threshold. Am I paranoid about leaving the gear up? Maybe I am. But since when is this type of paranoia such a bad thing?

Now that you know about operating the landing gear, it's a good time to talk about what you can do to keep the engine from getting too cool or too hot.

Keeping Your Cool with Cowl Flaps

By now you've probably guessed that our powerplant (the engine) is also a heat plant. All that local motion results in the production of calories galore, with every bit of the heat looking for a home. One of the things you must be aware of in a complex airplane is preventing engine overheating when operating at high power settings. Unfortunately, engine cooling is least effective at high power settings and low airspeeds, where a limited amount of air enters the engine cowling. This condition just happens to describe our airplane during a climb, doesn't it?

While overheating is damaging, excessive cooling can also shorten engine life, as I've already discussed. Long or rapid descents under low power conditions might cause shock cooling of the engine, a condition in which the various metals of the cylinders cool suddenly and at different rates. This can lead to something getting bent out of shape. That can lead to buying expensive new engine parts in an actual airplane, so pilots generally have a strong imperative to avoid doing it.

In addition to properly planning your descents, there's something else you can do to help keep the engine from getting too hot during a climb and too cold during cruise and during descents. I'm referring to using something known as the cowl flaps (Figure 1-4).

Figure 1-4

Just to be clear here, I said *cowl* flaps, not *cow* flaps. The airplane doesn't have anything associated with a cow on it, not even the "rrrrr-udder" pedals. (Sorry, I had to do that.)

Cowl flaps are moveable sections of metal under the engine cowling (thus the origin of the phrase "cowl" flaps) that can be manually opened or closed from the cockpit. All the pilot needs do is move a small lever (Figure 1-5).

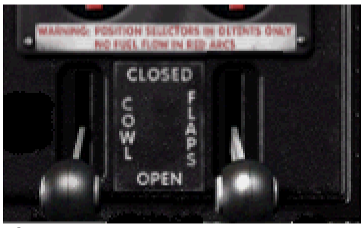

Figure 1-5

Keeping the cowl flaps closed (Figure 1-6) helps restrict the flow of air over the engine and through the cowling. This helps maintain warmer engine temperatures during cruise flight as well as during a descent. Opening the cowl flaps before takeoff and during climbs allows more air to flow over the engine and through the cowling, which helps prevent engine overheating.

Figure 1-6

Of course not all airplanes have cowl flaps. These are usually found on airplanes with larger engines, typically having 200 horsepower or more, like the Baron.

Your job will be to ensure that the cowl flaps are always open for takeoff and climbs, and always closed for cruise and descents. In real life, like a lizard eyeing a juicy, tasty-looking fly, we'd carefully monitor our cylinder head temperatures (CHT) and oil temperatures to keep these temperature values in the green. I guess this means we'd act just like a monitor lizard, except we'd be doing the fly(ing) instead of eating one (don't mind me, I just like my job).

At this point, you've had your hands full with gear handles and cowl flap levers, neither of which have much to do with operating the engine. So let me put a little spin on this lesson by introducing you to the propeller. Then I'll help you get a grip on the throttle control. These two items are a little different from what you've experienced when flying the Shyhawk SP, but I know you'll find them interesting.

The Big Spin on the Propeller

Propellers come in all sizes and colors, but they are of two basic types: fixed-pitch and constant speed. In an airplane with a fixed-pitch prop (like the one of the Skyhawk SP you've flown), one lever—the throttle—controls both power and propeller rpm. The Baron, however, has what is known as a *constant-speed propeller*, which means there are separate controls for engine power and propeller rpm.

The Skyhawk SP's fixed-pitch propeller had its pitch (angle of attack) fixed or made permanent during the forging process. The angle is set in stone (actually, set in aluminum). This pitch can't be changed except by replacing the propeller, which pretty much prevents you from changing the propeller's pitch in flight. Fixed-pitch props are not ideal for any single thing, yet they are, in many ways, best for everything. They represent a compromise between a propeller blade's best angle of attack for climb and its best angle for cruise. Fixed-pitch propellers are simple to operate, and easier (thus less expensive) to maintain.

As I've already mentioned, on fixed-pitch propeller airplanes like the Skyhawk SP, engine power and engine rpm are both controlled by the throttle. One lever does it all, power equals rpm, and that's that. Complex airplanes, however, have something known as a *constant-speed* (or, controllable-pitch) propellers.

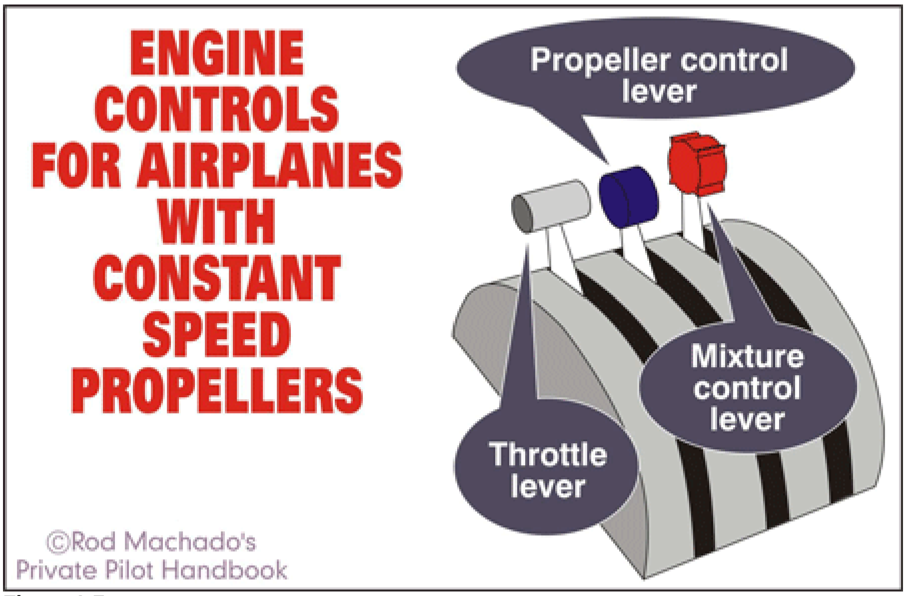

Figure 1-7

Airplanes with these propellers usually have both a throttle and a propeller control, so you manage engine power and propeller rpm separately as shown in Figure 1-7. (Since you may want to fly a single-engine complex airplane at some point, the figures shown here represent a single-engine complex airplane, despite the fact that you're flying a Baron. So, just double everything I say—except the jokes—to make the material applicable to the Baron).

On airplanes with constant-speed propellers, movement of the throttle determines the amount of fuel and air reaching the cylinders. Simply stated, the throttle determines how much power the engine can develop. Movement of the propeller control changes the propeller's pitch (its angle of attack); which directly controls how fast the propeller rotates (its speed or rpm) as shown in Figure 1-8.

Figure 1-8

Although throttle determines engine power, propeller pitch determines how efficiently that power is used. Let's examine how the controllable propeller works. Then we'll examine why changing the propeller's pitch in the Baron is such a helpful thing.

The Propeller Control Goal

Forward movement of the propeller control causes both halves of the propeller to rotate about their axes and attack the wind at a smaller angle (i.e., take a smaller bite of air) as shown in Figure 1-9.

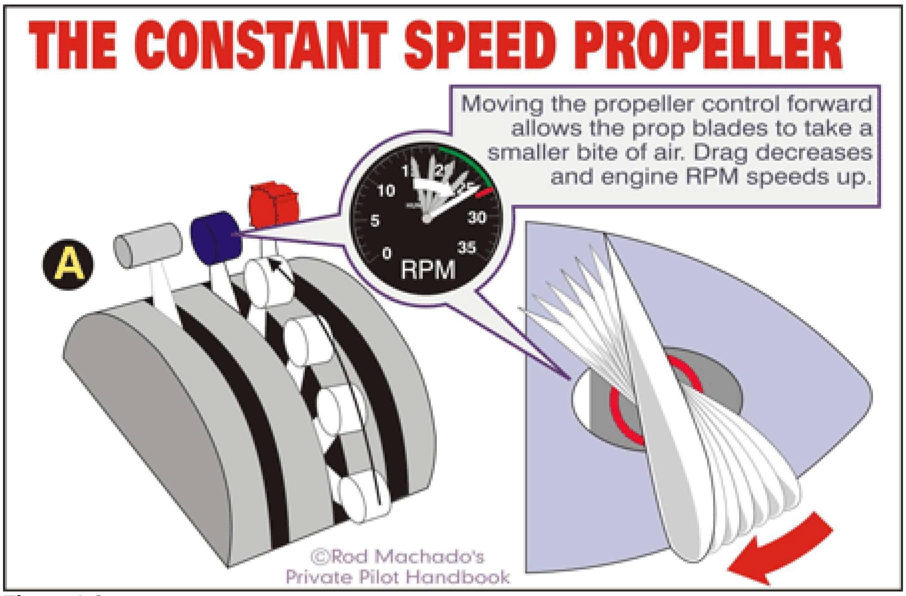

Figure 1-9

From our earlier discussion on aerodynamics, you know that a smaller angle of attack means less drag and less resistance to forward motion; therefore, moving the propeller control forward increases propeller rpm. Pulling the propeller control rearward causes the propeller to attack the wind at a larger angle of attack (that is, take a larger bite of air). Propeller drag increases and engine rpm slows as shown in Figure 1-10.

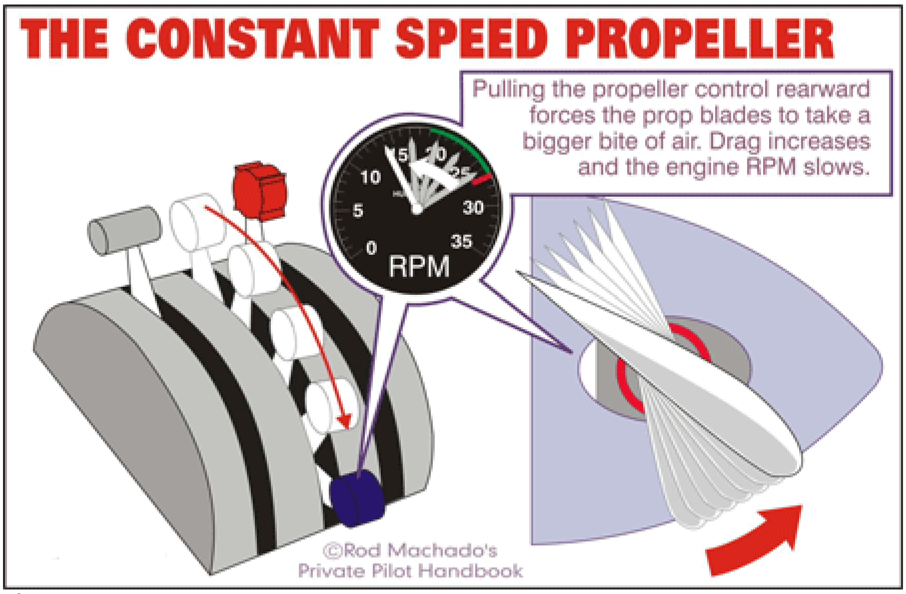

Figure 1-10

Just as the tachometer tells you how fast the propeller spins (its rpm), the manifold pressure gauge tells you how much throttle is applied, and it gives you an approximate measure of engine power (Figure 1-11).

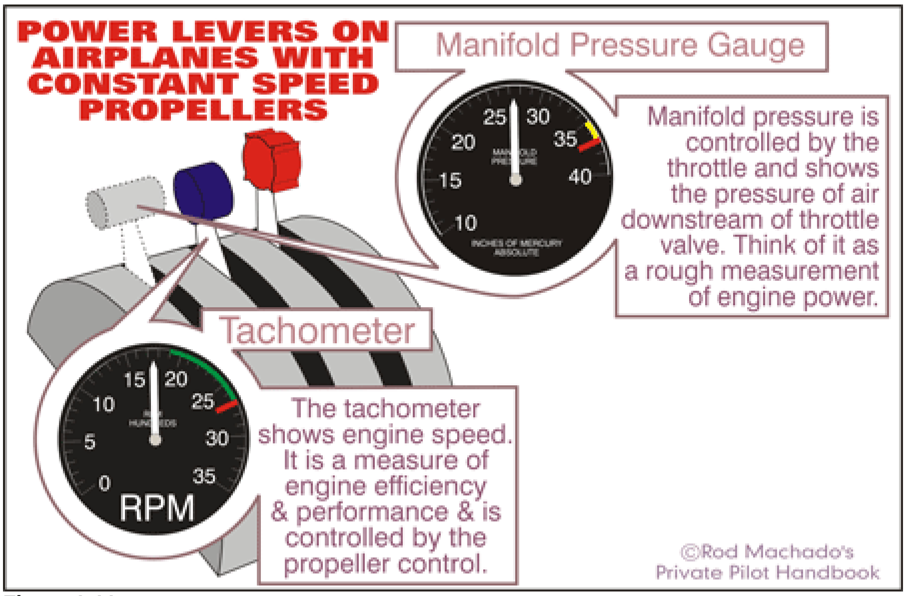

Figure 1-11

To understand what manifold pressure means, I need to give you a little lesson on the first cycle of a four cycle airplane engine.

Getting Your Strokes Right

Airplane engines have four cycles: intake, compression, power, and exhaust.

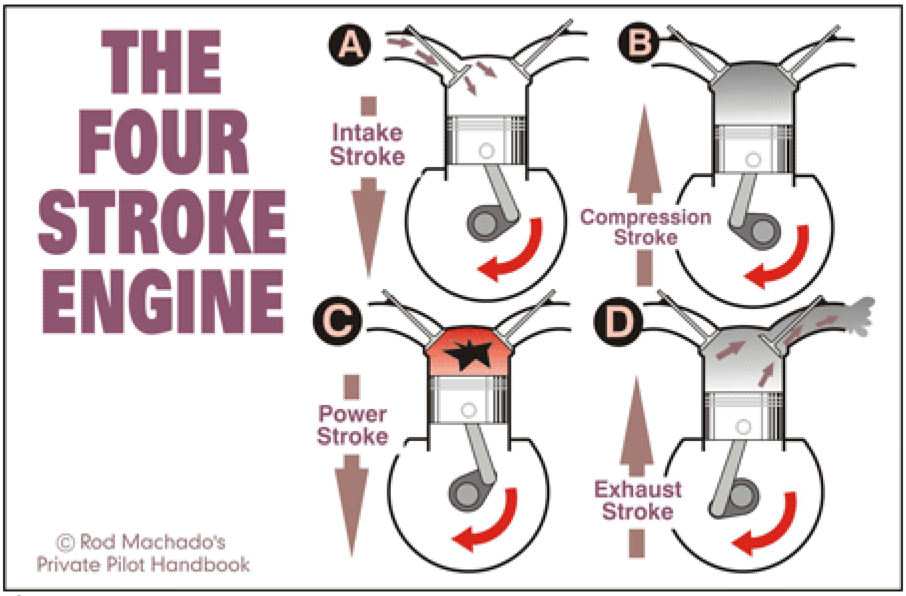

Figure 1-12

The *intake cycle* is what's important here (Figure 1-12, position A). This cycle occurs as the piston moves downward and the intake value opens. Since the cylinder was filled with the piston as the cycle started, moving the piston downward creates a vacuum. Think of a vacuum as the presence of nothing, or the absence of everything (your choice). Nature abhors a vacuum (that's "vacuum," not "vacuum cleaner," so this isn't a reason for not cleaning your house). You've heard that fools rush in where angels fear to tread? While the piston is in its downward journey, a mixture of fuel and air rushes into the cylinder (Figure 1-12, position A). This sucking action is responsible for the term *manifold pressure*. It's the sucking action of the descending piston that creates a vacuum in the induction system (Figure 1-13).

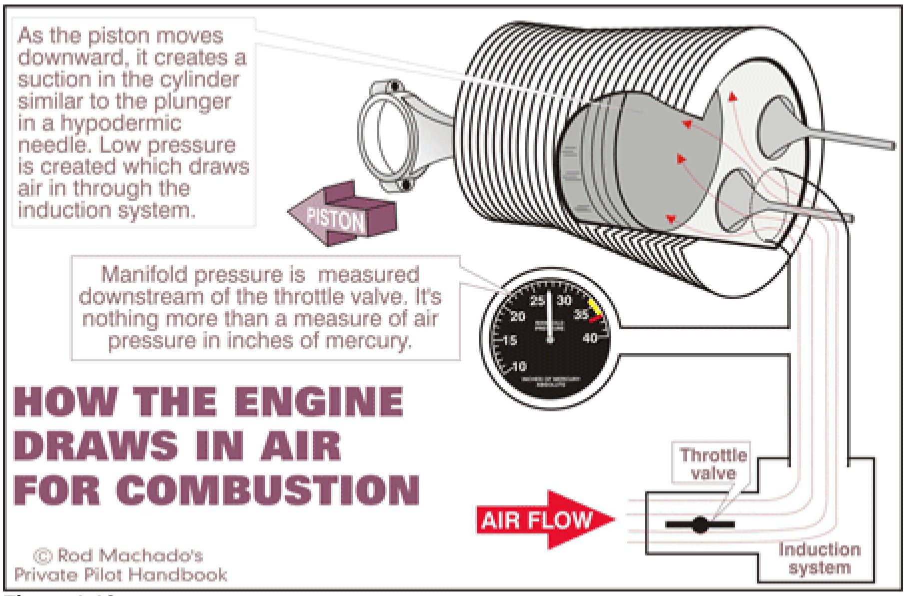

Figure 1-13

With the throttle closed, the throttle valve in the induction system prevents air (and thus fuel) from rushing into the cylinders and powering the engine. But what is it that forces air into the induction system in the first place? Yes, it's the pressure of the surrounding atmosphere. Because atmospheric pressure is higher than the pressure within the induction system, air flows into the cylinders. Simply stated, the atmosphere wants to push air into the induction system (toward the suction created by the downward moving pistons). The amount of this push is measured by the manifold pressure gauge (which is nothing more than a barometric measuring device calibrated to read pressure in inches of mercury—just like altimeters).

The Pressure is On

Manifold pressure is measured downstream of the throttle valve as shown in Figure 1-13. When the throttle is closed, air outside the engine (under higher atmospheric pressure) can't flow into the induction system, despite the vacuum on the engine side of the throttle valve. Figure 1-14 shows a manifold pressure of 14 inches of mercury with a closed throttle. The engine is sucking as hard as it can but the outside air can't get past the closed throttle valve.

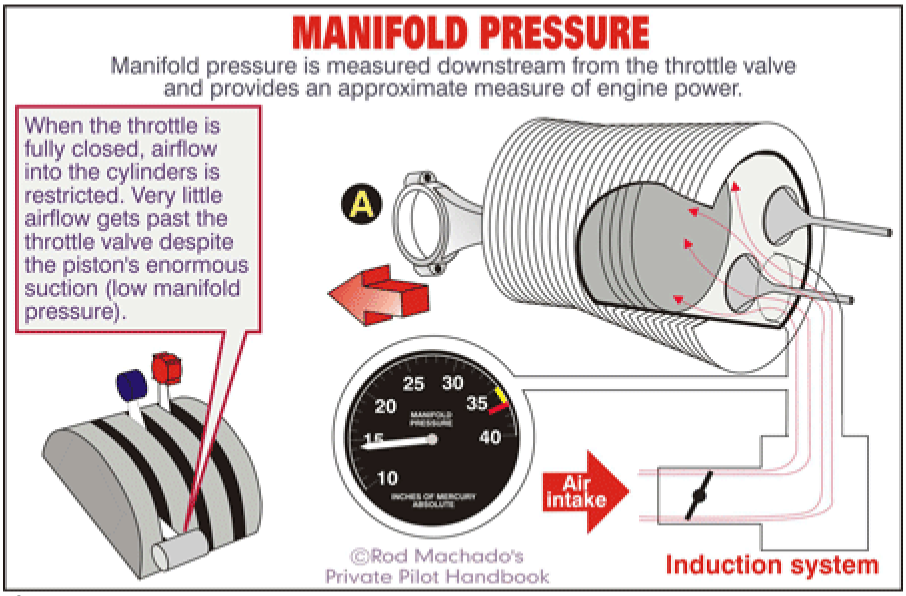

Figure 1-14

Opening the throttle slightly causes an increase in manifold pressure as shown in Figure 1-15.

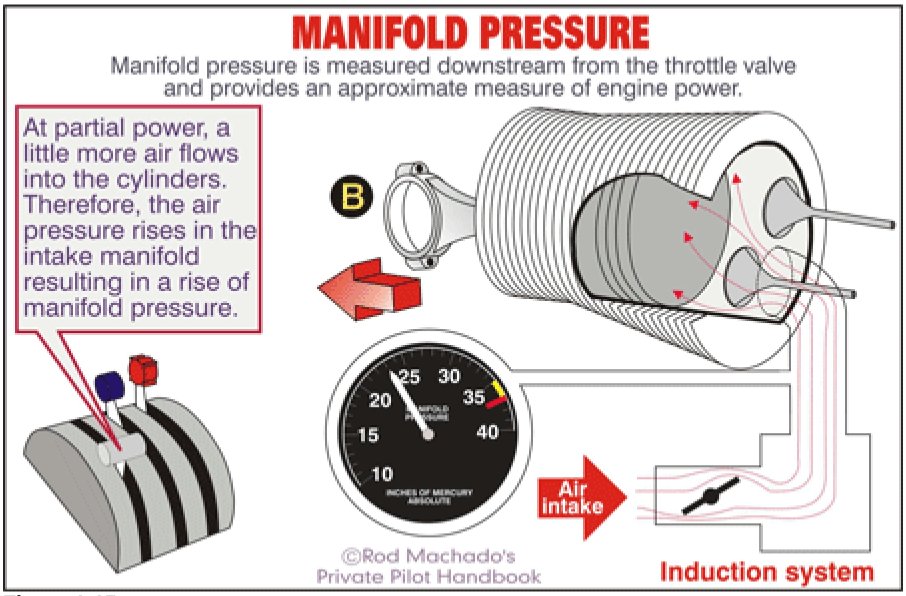

Figure 1-15

More air and fuel are drawn inside the engine, and power increases. Eventually, as the pilot opens the throttle fully (Figure 1-16), the pressure downstream of the throttle valve approaches that of the atmosphere. In other words, the air is being forced into the induction system at the maximum pressure the atmosphere is capable of pushing.

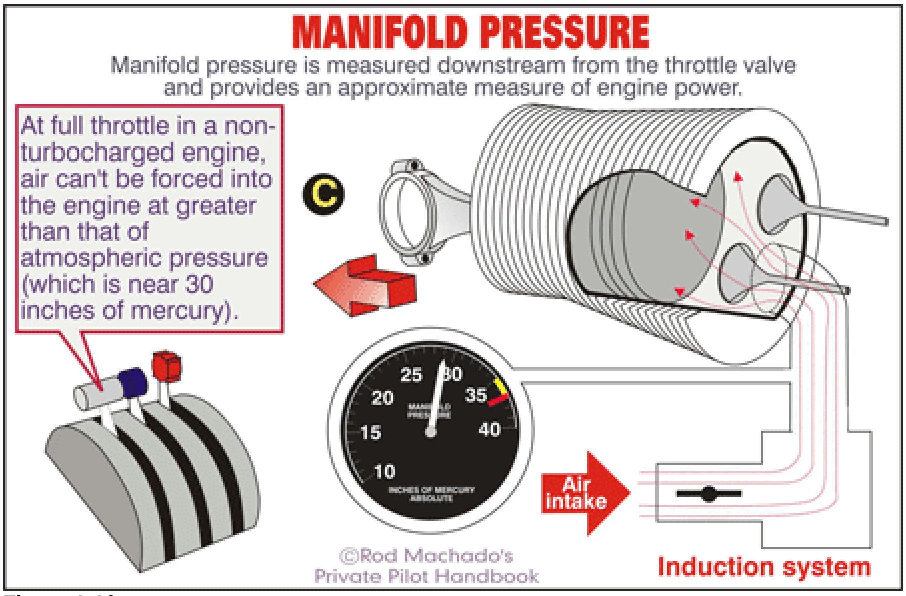

Figure 1-16

Under normal conditions, the engine's manifold pressure can't rise above atmospheric pressure. The atmosphere can only push an amount equal to how much it weighs. At sea level, atmospheric pressure weighs enough to push a column of mercury 30 inches into a glass tube containing a vacuum (Figure 1-17).

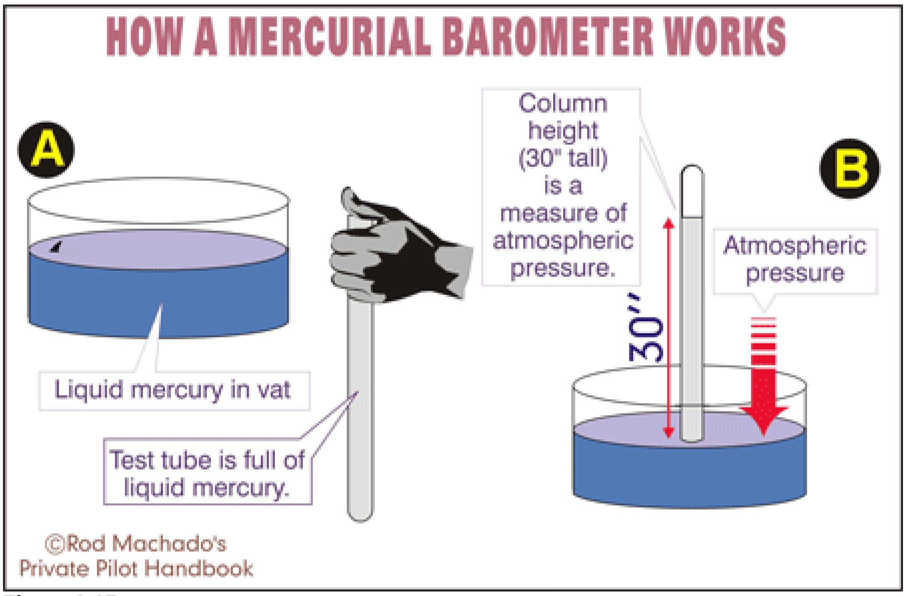

Figure 1-17

As a measurement of the atmosphere's weight, we say that the outside air pressure is 30 inches of mercury. Therefore, the engine's manifold pressure at full throttle is a little less than 30 inches (it's a little less because of air friction and intake restrictions within the induction system). Clearly, then, manifold pressures near 30 inches of mercury signifies more power is being developed by the engine. On the other hand, low manifold pressures (say 15 inches or so) indicate less fuel and air is entering the cylinders and less power is being produced.

As the airplane climbs, you'll notice the manifold pressure decreases even though the throttle is fully opened. Why? Atmospheric pressure decreases as you ascend. It decreases approximately one inch of mercury for every thousand feet of altitude gain as shown in Figure 1-18 (and increases approximately one inch of mercury for every thousand feet of altitude loss).

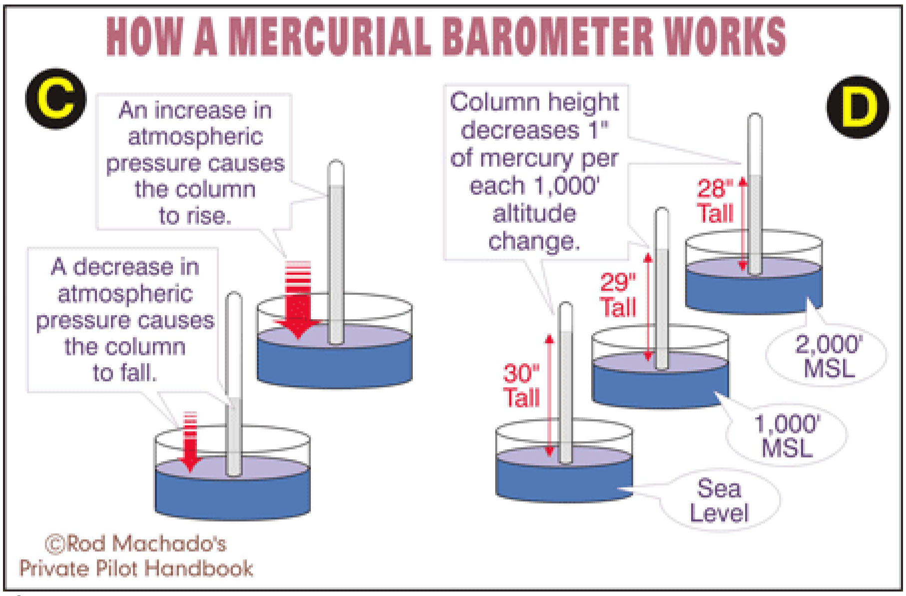

Figure 1-18

At sea level you can develop approximately 30 inches of manifold pressure with full throttle. At 5,000 MSL, however, your manifold pressure will be approximately 25 inches with full throttle (Figure 1-19).

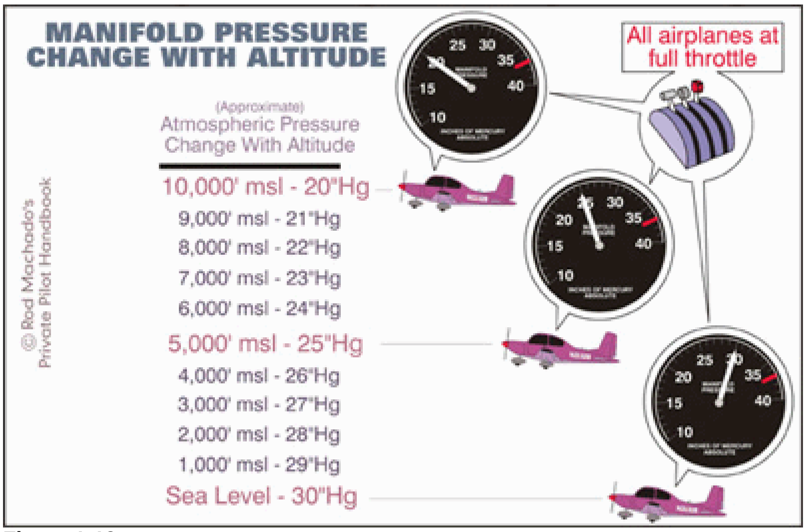

Figure 1-19

Remember, under normal conditions the atmosphere can't force air into the induction system at more than its own pressure (its own weight).

I mentioned that engine power is controlled by the throttle. That's basically true; but engine power can also be varied slightly by the rpm you've selected. In other words, the total power produced by the engine is really a combination of both manifold pressure and engine rpm. Think of it this way: you're on a 2,000 calorie diet. You can eat 1,500 calories for breakfast, 500 for lunch and skip dinner; 1,000 for breakfast, and 500 each for lunch and dinner, and so forth. There are lots of combinations that will yield 2,000 calories.

The same is true on a constant-speed prop plane. Different combinations of manifold pressure and engine (prop blade) rpm can be used to attain a given power setting. Figure 1-20 shows how this works for the Baron.

Section V
Performance

BEECHCRAFT
Baron 58

CRUISE POWER SETTINGS

20° RICH
OF PEAK EGT

RECOMMENDED CRUISE POWER
23 IN. HG (OR FULL THROTTLE)
@ 2300 RPM (5200 LBS)

	PRESS. ALT.	IOAT		MAN. PRESS.	FUEL FLOW/ ENGINE		AIRSPEED	
	FEET	°C	°F	IN. HG	PPH	GPH	KIAS	KTAS
ISA -20°C (ISA -36°F)	SL	2	28	23	81	13.5	176	170
	2000	−6	21	23	84	14.0	178	176
	4000	−10	14	23	87	14.5	179	182
	6000	−14	7	23	91	15.2	180	188
	8000	−18	0	22	89	14.8	177	190
	10000	−22	−7	21	84	14.0	169	188
	12000	−26	−14	19	78	13.0	162	185
	14000	−30	−21	18	73	12.2	154	182
	16000	−34	−29	17	68	11.3	146	178
STANDARD DAY (ISA)	SL	18	64	23	78	13.0	171	171
	2000	14	57	23	81	13.5	173	177
	4000	10	50	23	85	14.2	174	183
	6000	6	44	23	88	14.7	175	190
	8000	3	37	22	87	14.5	171	192
	10000	−2	29	21	81	13.5	164	189
	12000	−6	22	19	76	12.7	156	186
	14000	−10	15	18	71	11.8	149	183
	16000	−14	7	17	66	11.0	140	178
ISA +20°C (ISA +36°F)	SL	38	100	23	76	12.7	166	171
	2000	34	93	23	79	13.2	168	178
	4000	30	86	23	82	13.7	169	184
	6000	26	80	23	85	14.2	169	191
	8000	23	73	22	84	14.0	166	193
	10000	19	65	21	78	13.0	159	190
	12000	14	58	19	73	12.2	151	187
	14000	10	51	18	68	11.3	143	143
	16000	6	43	17	64	10.7	135	178

NOTES: 1. SHADED AREA REPRESENTS OPERATION WITH FULL THROTTLE.
2. FULL-THROTTLE MANIFOLD VALUES ARE APPROXIMATE.
3. FUEL FLOWS ARE TO BE USED FOR FLIGHT PLANNING ONLY AND WILL VARY FROM AIRPLANE TO AIRPLANE. LEAN USING THE EGT.

Figure 1-20

Any of the manifold pressure and engine rpm combinations listed can be selected to obtain the desired engine power output in cruise flight. The throttle selects the desired manifold pressure and the propeller control selects engine rpm.

Why would you want so many combinations of manifold pressure and rpm? The reason is that fuel consumption, airspeed and the percent of power produced all vary based on different combinations of manifold pressure and rpm. Noise levels and smoothness of engine operation also vary based on rpm. Even some of your airborne electronic equipment can be affected by engine speed. At least you have a choice among different combinations for power selection.

The big question is, "Why have a propeller that can change its pitch in flight in the first place?" After all, this is just another airplane knob you have to contend with, isn't it? Yes it is. But it's worth the trouble.

Airplanes equipped with constant-speed propellers are much more versatile in their operation. For instance, fixed-pitch propeller airplanes have their propellers permanently configured (pitched) for either a fast cruise, a fast climb, or somewhere in between (like the Skyhawk SP). You can't change their pitch in flight. Airplanes with controllable-pitch propellers, however, can essentially reshape the prop, by changing its pitch, from the cockpit. This means you can obtain the optimum angle of attack for climb or cruise. Let's take a look at how a different pitch may result in increased performance. (As a reminder, while I'm only referring to the operations of a single engine in this lesson, this obviously applies to operating both engines in the Baron.)

Low Pitch and High rpms

When climbing a very steep hill in a car, you want your automobile's engine to develop nearly 100 percent of its maximum power; that's why you start off in low gear. Low gear results in high engine rpm, thus more engine power being transferred to the wheels

(Figure 1-21, position A). As a result, your car is less likely to bog down during the climb. Pay attention the next time you walk up a steep hill. You'll find yourself using lots of short steps (high rpm) instead of the long strides you'll use on the flatlands.

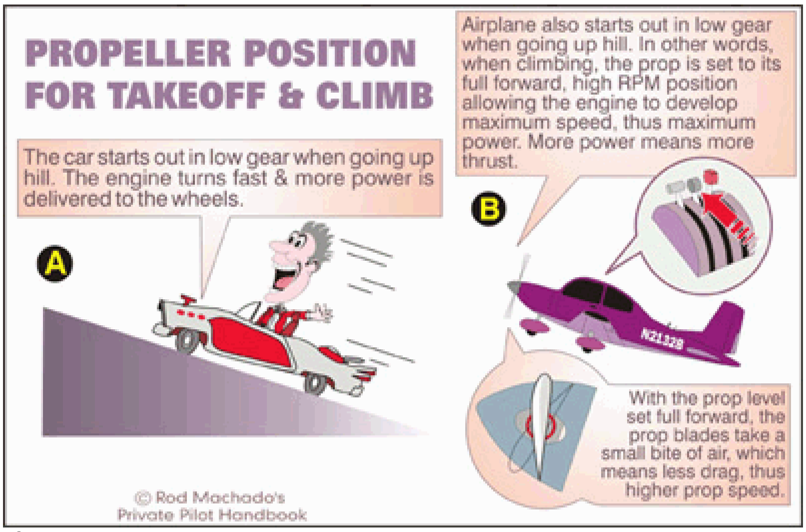

Figure 1-21

The same philosophy applies to airplanes. During a climb, we want the airplane's engine to develop maximum power. This allows maximum thrust to be produced (remember, it's excess thrust that allows an airplane to climb).

Engine power is dependent on its rpm. For an engine to develop its maximum power, it must be operated at its highest allowable rpm. At any lower rpm the engine develops only a fraction of its total horsepower. That's why on takeoff (or during go-arounds) we want the propeller set to its lowest pitch (highest rpm) position (full forward on the prop lever). In this position the propeller experiences less wind resistance, resulting in less drag and higher engine rpms (Figure 1-21, position B). Under these conditions the engine develops maximum power, thus maximum thrust for climbing and accelerating.

You may be thinking, "How can the propeller deliver maximum thrust if it doesn't take a big bite of air?" Think of it this way: If the propeller does take a big bite of air (a large angle of attack), it will surely develop more thrust—but only if the propeller continues to turn over at a high speed. That's the problem! Taking such a large bite of air increases the propeller's drag (just like a wing at a large angle of attack). This disproportionally decreases the propeller's speed and prevents the engine from developing its maximum horsepower (it bogs it down, like the car). The final result is that the propeller produces less thrust than it's capable of producing.

One last way of conceptualizing this is to think about a blender. (If you don't have one, simply send out a few wedding invitations). If hard vegetable fiber is dropped in before the blades have a chance to spin up, the machine bogs down (rpms stay low). Nothing gets chopped because the motor has less spinning force or torque at slower speeds. However, once the blender's blades spin to a fast speed, nothing seems to resist the spinning force of the blades. High motor rpms mean maximum power is developed and the blender's blades resist slowing when they encounter thick vegetable fiber. The net result of higher engine rpms for the airplane is that maximum engine thrust is produced when the propeller spins faster, even though the blades are at a lower pitch.

High Pitch and Low rpms

Are there times when you don't need to develop maximum engine power? Yes. For example, if you're on the freeway, your automobile only needs enough power to keep it moving at a reasonable speed—perhaps only 55 percent to 65 percent of its maximum power. High gear (low engine rpm) is selected to maintain freeway speeds (Figure 1-22, position A). High gear means the engine turns over at a lower rpm, thus producing only the horsepower needed to keep the car moving along at an acceptable pace. This is achieved with less fuel consumption than if the car were running flat out.

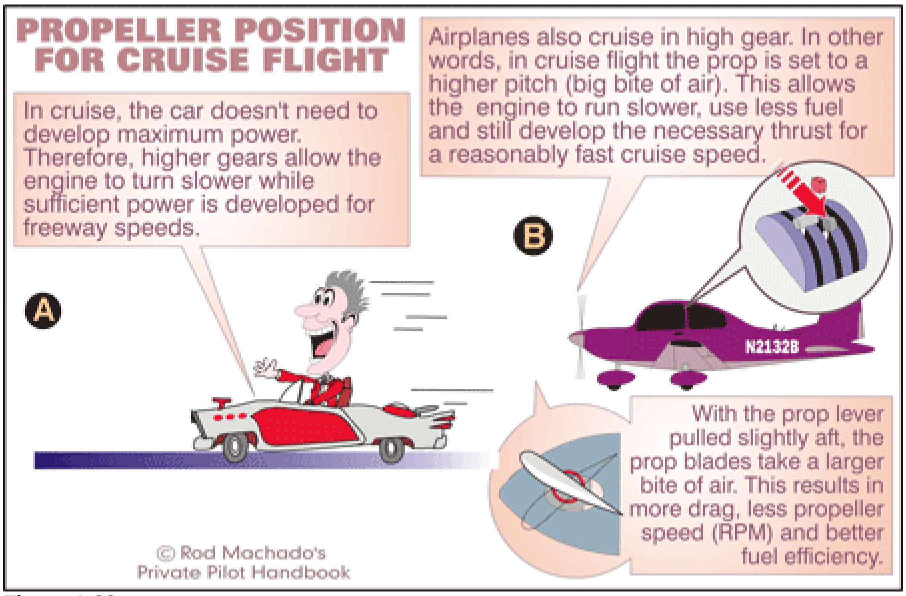

Figure 1-22

Airplanes are operated in a similar manner during cruise flight (Figure 1-22, position B). There is no need to develop maximum horsepower during cruise flight. Our concern is to obtain a reasonably fast airspeed while keeping the fuel consumption low. After all, we could operate our Baron in cruise flight at full throttle—but why? The larger drag associated with higher speeds would consume enormous amounts of fuel and not allow us to move all that much faster anyway (remember, total drag increases dramatically at higher airspeeds). Therefore, cruise flight is a tradeoff between high airspeed and low fuel consumption.

With the proper combination of manifold pressure and engine rpm, you can obtain a reasonably fast airspeed for a given rate of fuel consumption (See Figure 1-20 for a few of these combinations). In cruise flight we select the desired manifold pressure with the throttle, and engine rpm with the propeller control. Now the propeller produces a specific amount of lift (thrust) for a given (lower) fuel consumption.

Why Constant-Speed Propellers?

Controllable-pitch propellers on complex airplanes are of the *constant-speed* variety. Once the rpm is established, changes in manifold pressure (by moving the throttle) won't affect engine speed. In other words, opening (Figure 1-23) or closing (Figure 1-24) the throttle (or changing the airplane's attitude) doesn't vary the engine's rpm. This is why these controllable propellers are given the name constant-speed propellers. (Of course, if you pull the throttle all the way back, there's simply no power available to keep the propeller spinning. The engine's rpm has no choice but to drop.)

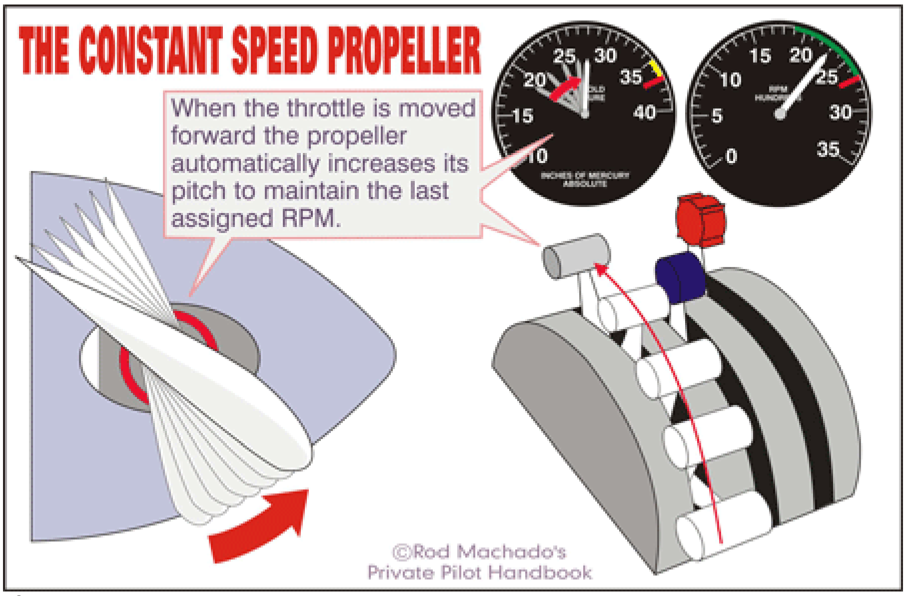

Figure 1-23

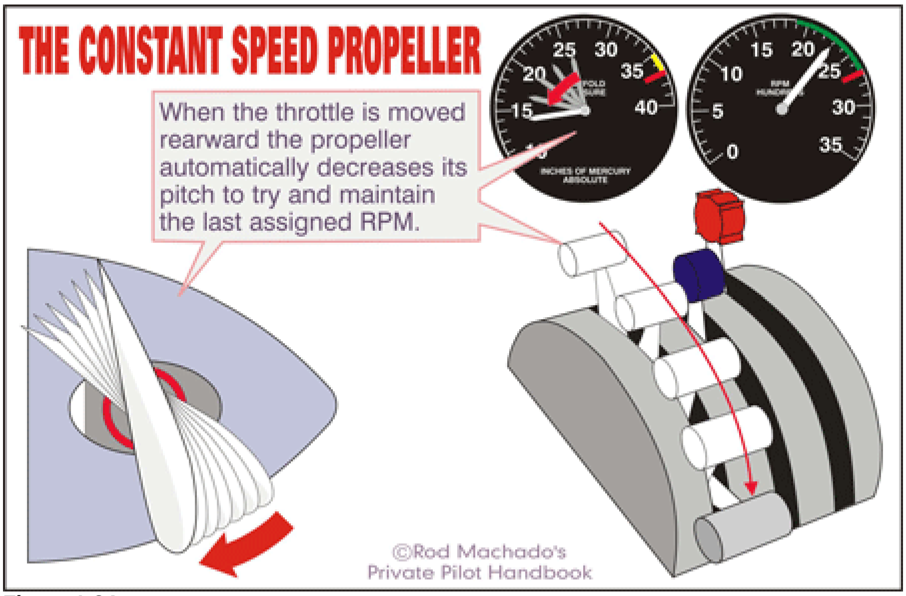

Figure 1-24

The reason constant-speed propellers are put on an airplane is to reduce a pilot's workload. Instead of having to readjust the rpm with every change in power, you simply set the rpm and it stays where it's put—just like your home thermostat keeps the temperature constant (although the thermostat in my home only has two settings: Cold and Kenya).

What is the value of having a propeller that maintains a preset (constant) speed? It provides you with one less item to readjust while managing power. Let's suppose the airplane's Pilot Operating Handbook suggests the most efficient use of engine power during climb occurs at 25 inches of manifold pressure and 2,500 rpm (pilots refer to this as 25 squared, which proves how weak some of them are in math). As you climb, the manifold pressure decreases approximately one inch per thousand feet (because the outside air pressure decreases one inch for every thousand feet altitude gain). Since you have a constant speed propeller, the rpm automatically stays set at 2,500, despite variations in manifold pressure (or throttle positions). All you need to do is keep adding throttle to maintain the desired manifold pressure during the climb; the rpm needs no adjusting.

In the Baron, all takeoffs will be made with full throttle (approximately 29 inches of manifold pressure) and propeller controls full forward, which will produce approximately 2,700 rpm. This is called *takeoff power* and we can be assured of obtaining maximum thrust in this condition. Once the airplane reaches a safe maneuvering altitude, however, we'll want to reduce power to the climb power setting of 25 inches of manifold pressure and 2,500 rpm. This prevents the engine for working too hard, possibly overheating and damaging itself. You can consider an altitude of 500 feet AGL a safe maneuvering altitude (unless I recommend a higher altitude in any lesson, which I might do). Why 500 feet? There's one school of thought that the first reduction of power after takeoff changes the engine's stress level, possibly exacerbating an already existing engine problem, thus instigating an engine failure. Therefore, it seems reasonable not to adjust power until reaching an altitude at which you can more easily maneuver the airplane and return for landing.

In cruise flight, we'll use manifold pressure settings around 19 to 23 inches and rpm values of around 2,300, depending on what the lesson specifics call for.

Making Power Changes

With the ability to vary propeller pitch you need to understand a few very important principles about power management. It's relatively easy to overstress an engine if the throttle and propeller controls aren't used in the proper order during power changes. I can't overstress this point.

For instance, suppose your manifold pressure and rpm are set at 23 inches and 2,300 rpm (Figure 1-25).

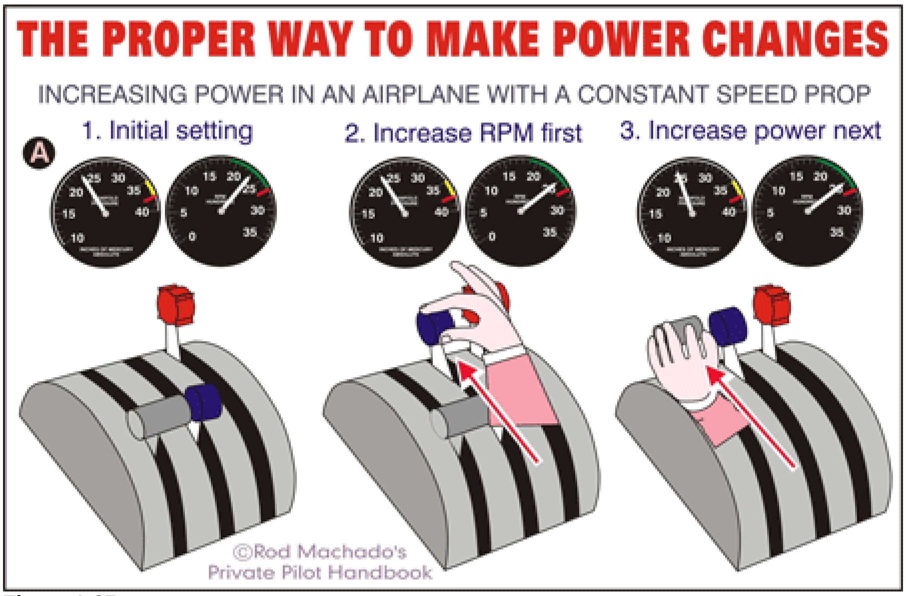

Figure 1-25

Now suppose that you want to increase the manifold pressure and rpm to 25 inches and 2,500 rpm. If you increase the manifold pressure to 25 inches first, it will increase the combustible mixture flowing to the cylinders. This would normally spin the propeller faster. Yet this doesn't happen, since the propeller takes a bigger bite of air to absorb the increase in power, thus maintaining its last established rpm. Cylinder stress increases as the propeller keeps the rpm from increasing (that is, the expanding gases push harder, yet are unable to move the pistons faster). Given enough cylinder stress, you could damage the engine.

When you want to increase both the manifold pressure and rpm, increase the rpm first, then increase the manifold pressure. In other words, move the propeller control forward first, the throttle next.

Follow the same philosophy when decreasing manifold pressure and rpm. Pull the throttle back first, followed by the propeller control, as shown in Figure 1-26. Another way of thinking about this is to keep the propeller control lever physically ahead of the throttle during all manifold pressure and rpm changes. A memory aid for this is to *keep the prop on top* (or always in front of the throttle).

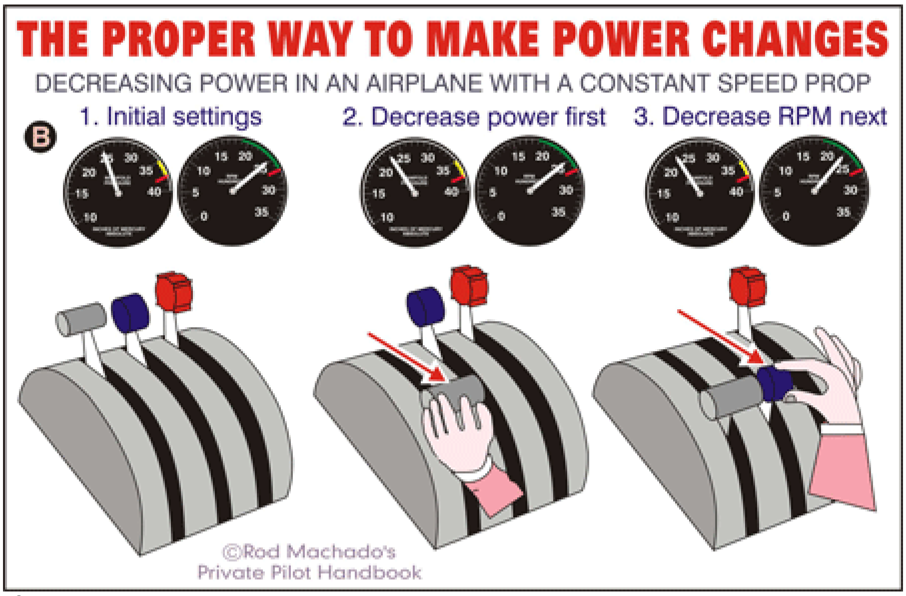

Figure 1-26

Propeller Tips and Other Ideas

Be aware that the propeller governor starts working only when the engine is operating above a specific rpm and not below. In other words, moving the throttle will change the rpm until the propeller reaches its minimum governing rpm.

Now you're ready to understand the "P" portion of the GUMP acronym we spoke of earlier. GUMP, as you recall, stands for: **G**as (fuel pump on), **U**ndercarriage (gear down), **M**ixture (full in) and **P**rop (propeller control full forward). Why is the propeller control put in the full-forward (low pitch—high rpm) position just before landing? It's done to prepare for the unlikely event there's a need to go-around. A *go-around* is an aborted landing that follows these steps: you apply full power, climb out, and go around for another attempt at landing. In this situation, it's important that the engine develop full power—just like on takeoff. That's why the propeller control is moved to the full-forward position before landing—exactly where it is during takeoff.

You now know the basics of what makes an airplane engine tick, kick, heat, and freeze. You don't, however, have to be a mechanic to be a good pilot. But now you at least have some vital information under your seatbelt—information that can help you fly safely and economically.

Here are just a few more tips you'll need to fly the Baron and other airplanes like it.

It's Fast, So Fly It Fast

The Baron, like many complex airplanes, is a fast airplane. To make the most of its speed, I want you to fly the airplane fast when and where it's appropriate. For instance, when you're descending to land at an airport, it doesn't make sense to descend at the same speed you'd use to fly your final approach to landing. You can descend up to speeds reaching 223 knots if you desire. This is the *maximum operating speed* of the Baron, also known as its high speed red line on the airspeed indicator. Of course, I'm not a big fan of operating near red line but it can legally be done (but I still don't recommend it).

The yellow arc on the Baron's airspeed indicator begins at 195 knots and extends to 223 knots, or red line. This is called the *caution range* and you should only be operating in this airspeed range if the air is perfectly smooth. Thus, the need to use caution. If the air is smooth, however, feel free to operate within this speed range. There's absolutely nothing wrong doing so. This certainly works to your advantage when you're descending to land at an airport and need to get down from cruise altitude. Descending at these higher speeds produces a lot of drag, allowing the airplane to descend quickly.

On the other hand, you can't come screaming into the airport environment at 220 knots without scattering all the other airplanes in the traffic pattern like bowling pins. That's why it's always best to enter the traffic pattern with your gear down. Since the maximum speed at which you can lower the gear is 152 knots, you'll have to slow the airplane down to at least this speed before entering the pattern. Once the gear is down, however, you can't just increase your speed back to 220 knots. That's because 152 knots is also the maximum gear-extended speed. In other words, because of either the structure of the gear or the gear doors, you shouldn't fly faster than 152 knots with the gear lowered. When you fly this lesson, you'll see how quickly the airplane descends with the gear lowered. Therefore, once the gear is down, if you need to lose a lot of altitude quickly, you'll be able to do so very quickly by increase your speed up to but not beyond 152 knots.

A Few Final Pointers

Here are a few final pointers that I want you to consider when flying the Baron:

- The Baron is a multiengine airplane and, like most similar airplanes, it has something known as Vmc or single-engine minimum control speed. This is the low-speed red line on the airspeed indicator (Figure 1-27) set at 85 knots. Although we won't go into detail on Vmc in this lesson, let it be said that we avoid rotating a multiengine airplane below its Vmc because the airplane would most likely become uncontrollable if an engine was lost (or even sputtered) below this speed.
- The blue line, at 101 knots on the airspeed indicator, indicates the best rate-of-climb speed on one engine for the Baron. You won't use this speed since you won't be losing engines during these lessons.
- The best rate-of-climb speed with both engines operating in the Baron is 105 knots. We'll use this speed for climb immediately after liftoff and hold it until reaching approximately 500 feet AGL (our safe maneuvering altitude). Then we'll increase our speed to 136 knots, which is a good cruise-climb speed. It's good for a number of reasons, in particular because this higher speed provides you with a good view over the cowling to look for traffic, and because it helps keep the engines cool.
- As a general rule, we will make all our approaches at 105 knots, unless we're trying to land on a particularly short field. Then we'll use a slower speed which we'll talk about in Commercial Pilot Lesson 2.
- You can apply 15 degrees of flaps at speeds up to 152 knots (the same as the maximum gear-extension and operating speed) Any more than 15 degrees of flaps requires you to be at 122 knots of below (the top end of the white arc) to prevent damaging those flaps. You'll notice that the Baron's flap switch has three settings as shown in Figure 1-28 **TRANS** or transition (meaning that the flaps are in the process of moving up or down), **APR** (approach flaps, 15 degrees) and **DN** (down, full flaps).

Figure 1-27

Figure 1-28

Now You're Ready

If you've gotten this far with this lesson, I think you've earned the right to begin your commercial training...so give it a try. Remember, it often takes several hundred hours of flight practice—to say nothing of ground study—for a pilot to earn a commercial license. So be patient: The Flight Simulator commercial lessons will be somewhat challenging. If it were easy, then everyone would be doing it.

Ok, see you in the cockpit. Click the **Fly This Lesson** link to practice what you've just learned.

Fly This Lesson Now
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