Condor Aero Club
Zelienople, PA

# The Constant Speed Propeller

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Founded 1957

# The BLUE Knob

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# Constant Speed Propeller

- The information contained in this presentation is generic in nature, derived from multiple sources and is not specific to the Piper Arrow or the Dakota unless noted.

- Please consult the Pilot's Operating Handbook for complete information.

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# What is a Constant Speed Propeller?

- A ***Constant-Speed Propeller*** is a variable-pitch propeller that automatically changes its blade pitch (Angle of Attack) in order to maintain a constant RPM, regardless of the operational conditions of the aircraft.

- As the blade angle is increased:
  - More lift (thrust) is produced
  - More drag is created, and more engine torque is required to spin the propeller
  - As a result, the engine RPM will decrease, which is MORE fuel efficient
  - ***Think of cruising your car on the highway in 5$^{th}$ gear for the best Miles per Gallon***

- As the blade angle is decreased:
  - Less lift (thrust) is produced
  - Less drag is created, and less engine torque is required to spin the propeller
  - As a result, the engine RPM will increase, which is LESS fuel efficient
  - ***Think of pulling away from a red light in 1$^{st}$ gear for best acceleration***

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# Why Do I Want One?

- A ***Fixed-Pitch Propeller*** is not efficient over a range of conditions.
- Fixed-Pitch Propellers are configured as either:
  - Climb Props (finer pitch)
    - Blade angle is optimized for takeoff and climb performance
    - Will be inefficient in cruise flight due to a lower angle of attack
  - Cruise Props (coarser pitch)
    - Blade angle is optimized for cruise performance
    - Will be inefficient during takeoff and climb due to a higher angle of attach
- A constant speed propeller gives you the ability to select the engine power and propeller RPM combination best suited for conditions. It also makes your airplane plane more adaptable to different phases of flight.
- It greatly improves ***fuel efficiency*** and ***performance***, especially at high altitude.
- It allows you to fly higher, farther and faster!

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# Why Do I Want One?

- How about a short comparison? KPJC-KIND, 290nm, no wind.

| | Archer (75% power) | Dakota (75% power) | Dakota (65% power) |
|---|---|---|---|
| Time | 2h 31m | 2h 09m | 2h 14m |
| Altitude | 6,500 | 6,500 | 8,500 |
| Fuel Burn | 24.6 | 27.0 | 23.4 |
| TAS | 115 | 135 | 130 |

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# How Does It Work?

- The propeller's blade pitch is changed hydraulically, using engine oil.

- The component in charge of it all is called the **Propeller Governor**. The governor moves oil back and forth through the propeller hub to make sure the prop is at the pitch and speed that you set with the blue prop lever.

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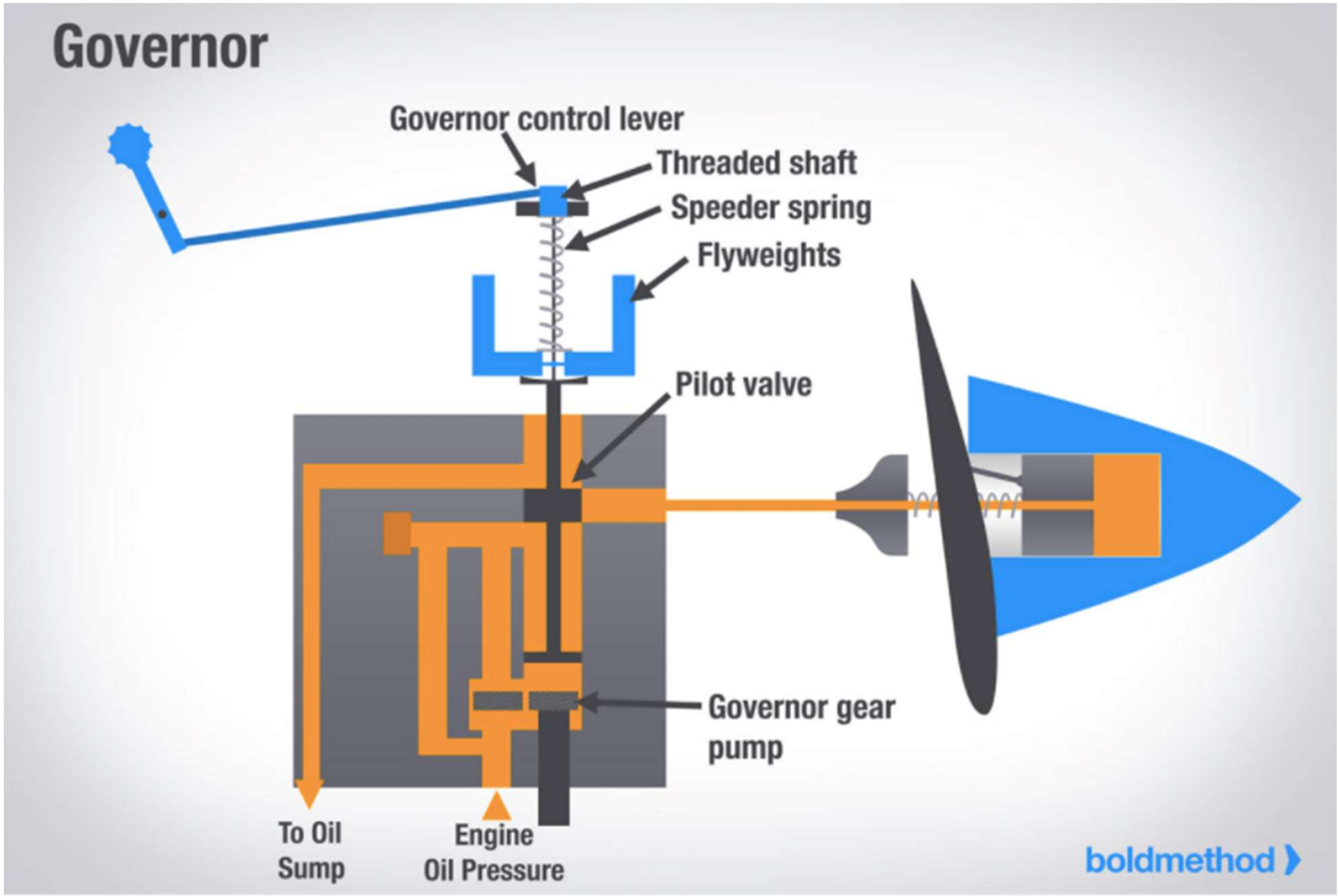
# How Does It Work?



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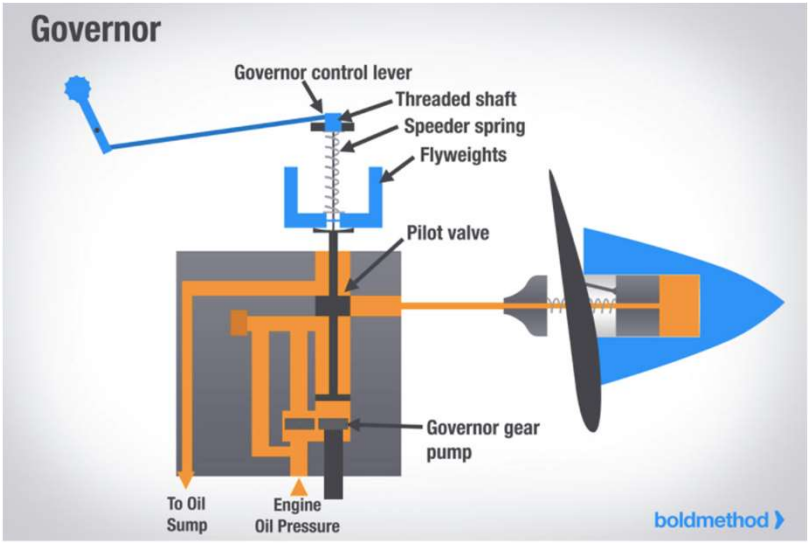
# How Does It Work?

- **Governor Control Lever:** The governor control lever is attached to the blue prop control lever in the cockpit through cables or linkages. When you move the prop lever forward or back, the control lever moves as well.

- **Threaded shaft:** The threaded shaft is connected to the governor control lever. It looks pretty much like a bolt, and it works the same way. When you turn it left, it moves up, and when you turn it right, it moves down. (righty tighty, lefty loosy!)

- **Speeder spring:** The speeder spring sits between the threaded shaft and the flyweights. When the threaded shaft moves down, the spring gets squeezed (its tension increases), and it forces itself down on the flyweights, causing them to 'fall' inward. When the threaded shaft moves up, the opposite happens.



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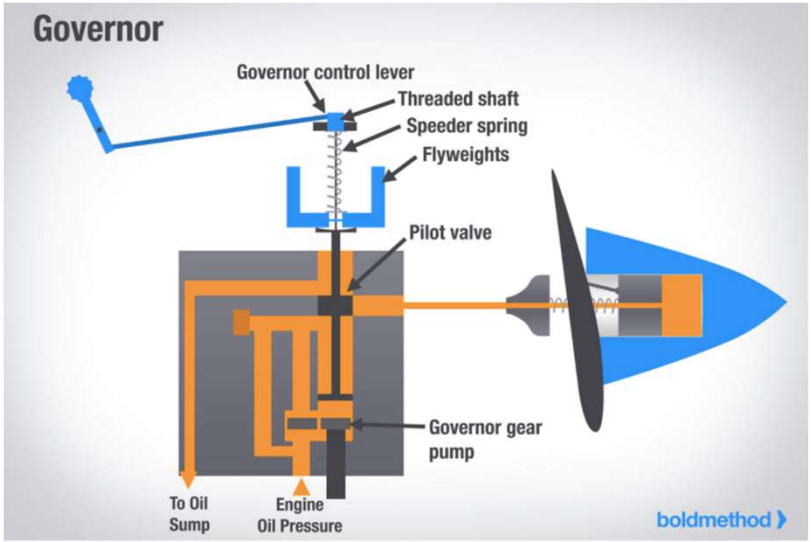
# How Does It Work?

- **Flyweights:** The "L" shaped flyweights, which spin around in a circle, are connected to the engine through gears. They're also connected to the pilot valve, which they move up and down. When the engine speeds up, the weights spin faster and fly out due to centrifugal force, lifting the pilot valve up. When the engine slows down, the weights fall in from pressure from the speeder spring, lowering the pilot valve.

- **Pilot Valve:** The pilot valve, which we mentioned is connected to the flyweights, is moved up and down by the flyweights, allowing oil to flow into, or out of, the propeller hub.

- **Governor Gear Pump:** The last major part of the governor is the gear pump. The pump boosts oil pressure before it heads out of the governor and into the propeller hub. With the boosted pressure, you get better, quicker response from the propeller when you move the lever back and forth in the cockpit.



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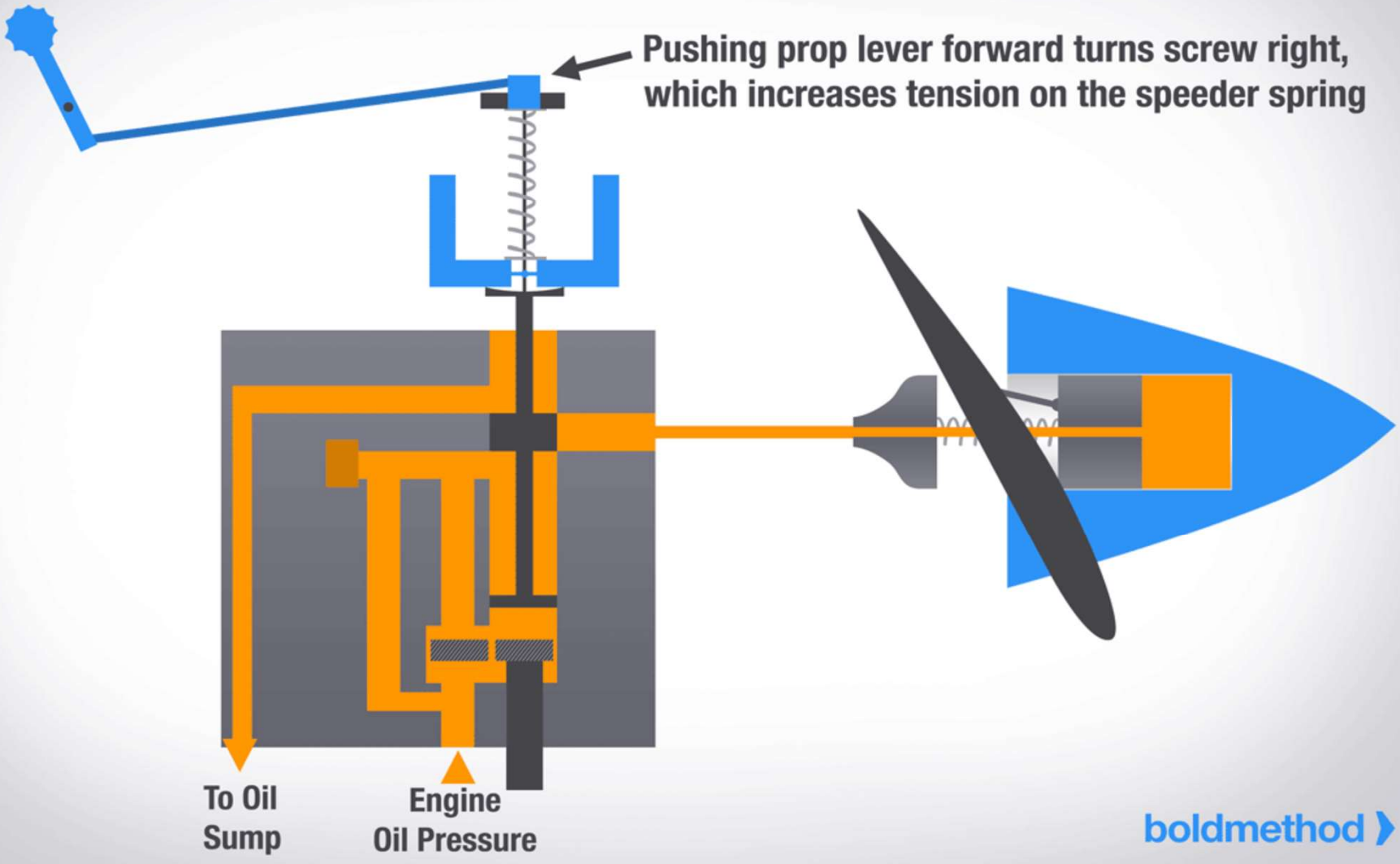
# Pushing Propeller Lever Forward

*"Shifting to 1st Gear to Pull Away from Traffic Light"*

## Push Lever Forward, Prop Takes 'Smaller Bite' Of Air



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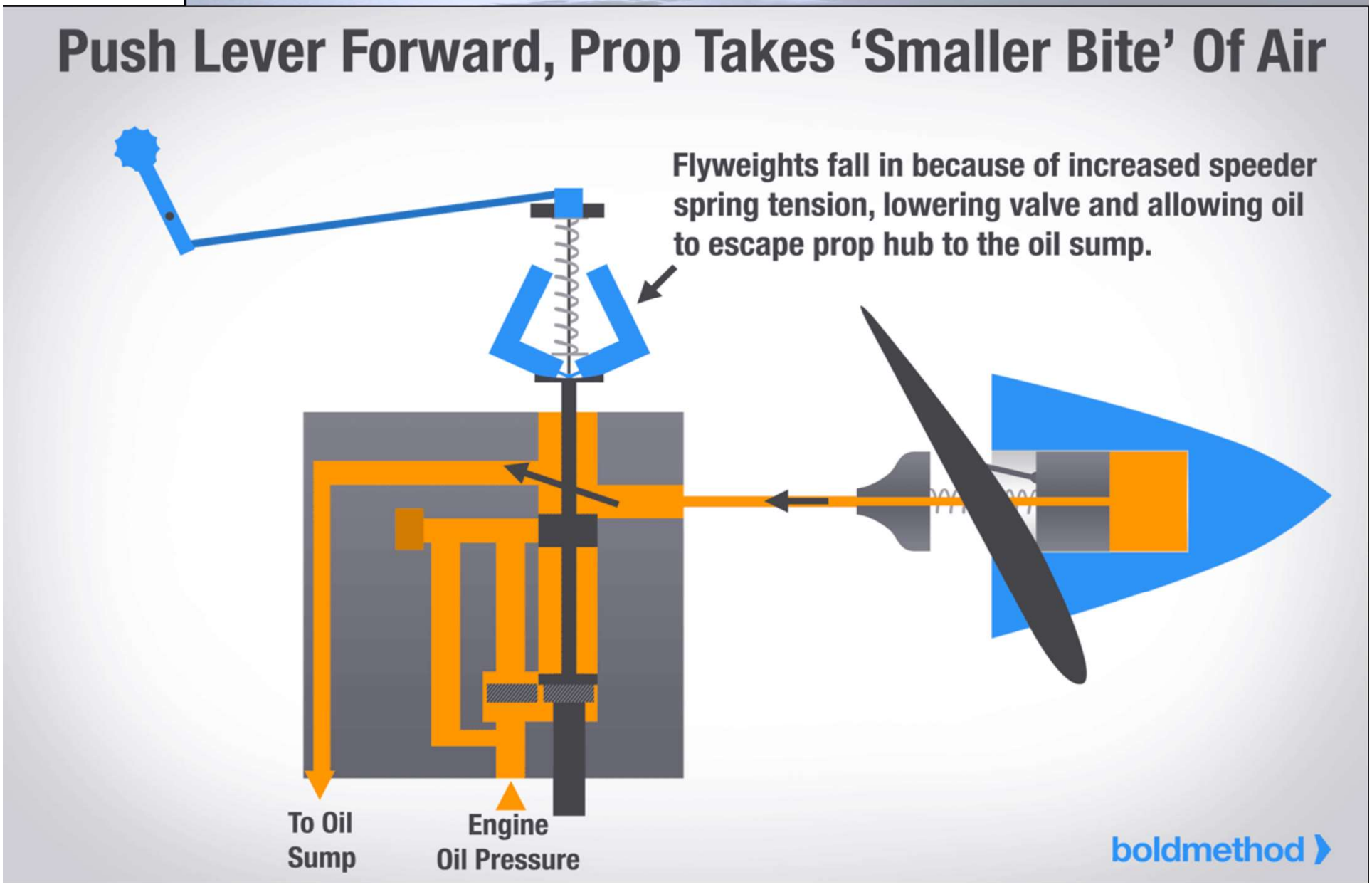

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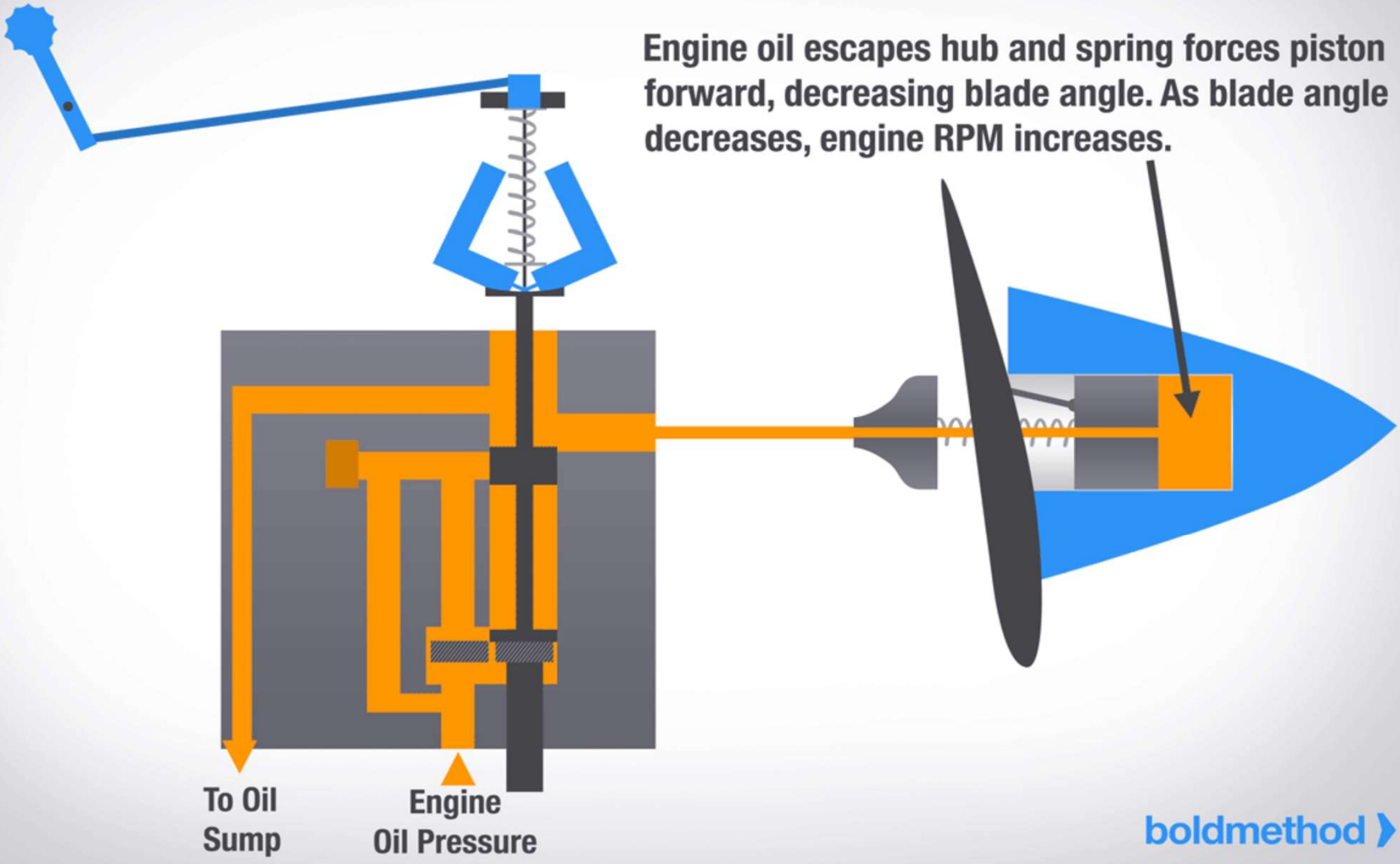

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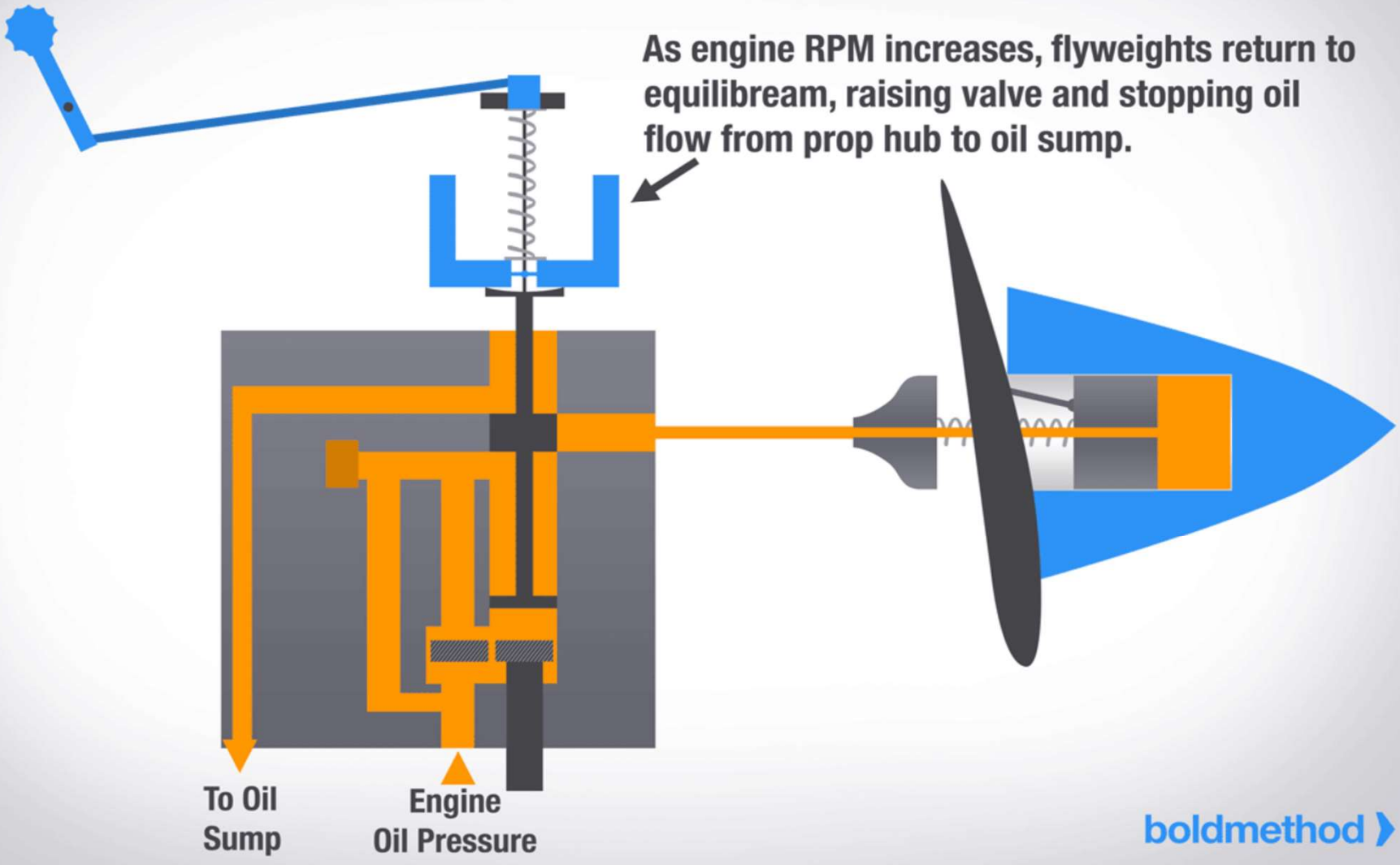

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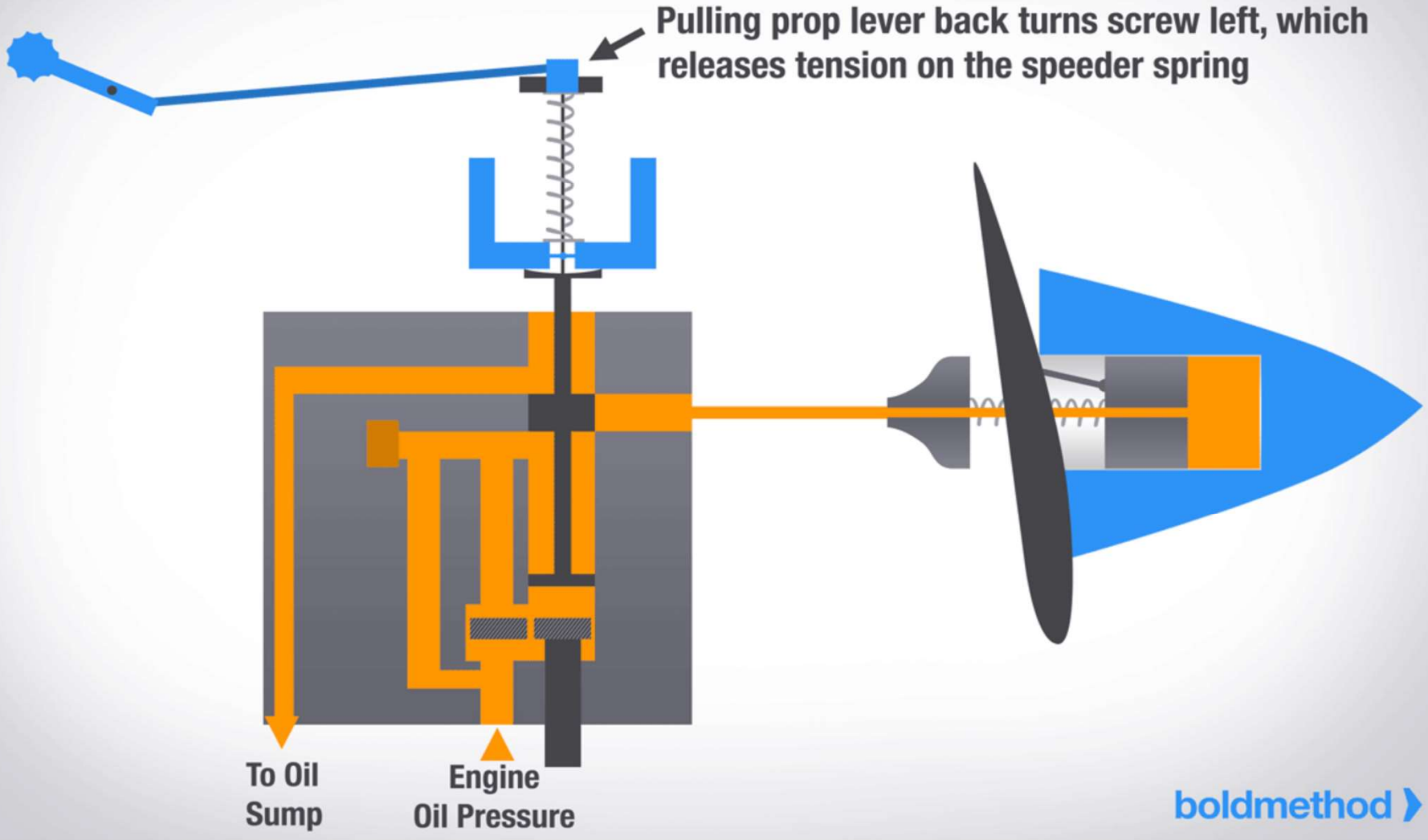
# Pulling Propeller Lever Back

*"Shifting to 5th Gear for Highway Cruise"*

## Pull Lever Back, Prop Takes 'Bigger Bite' Of Air



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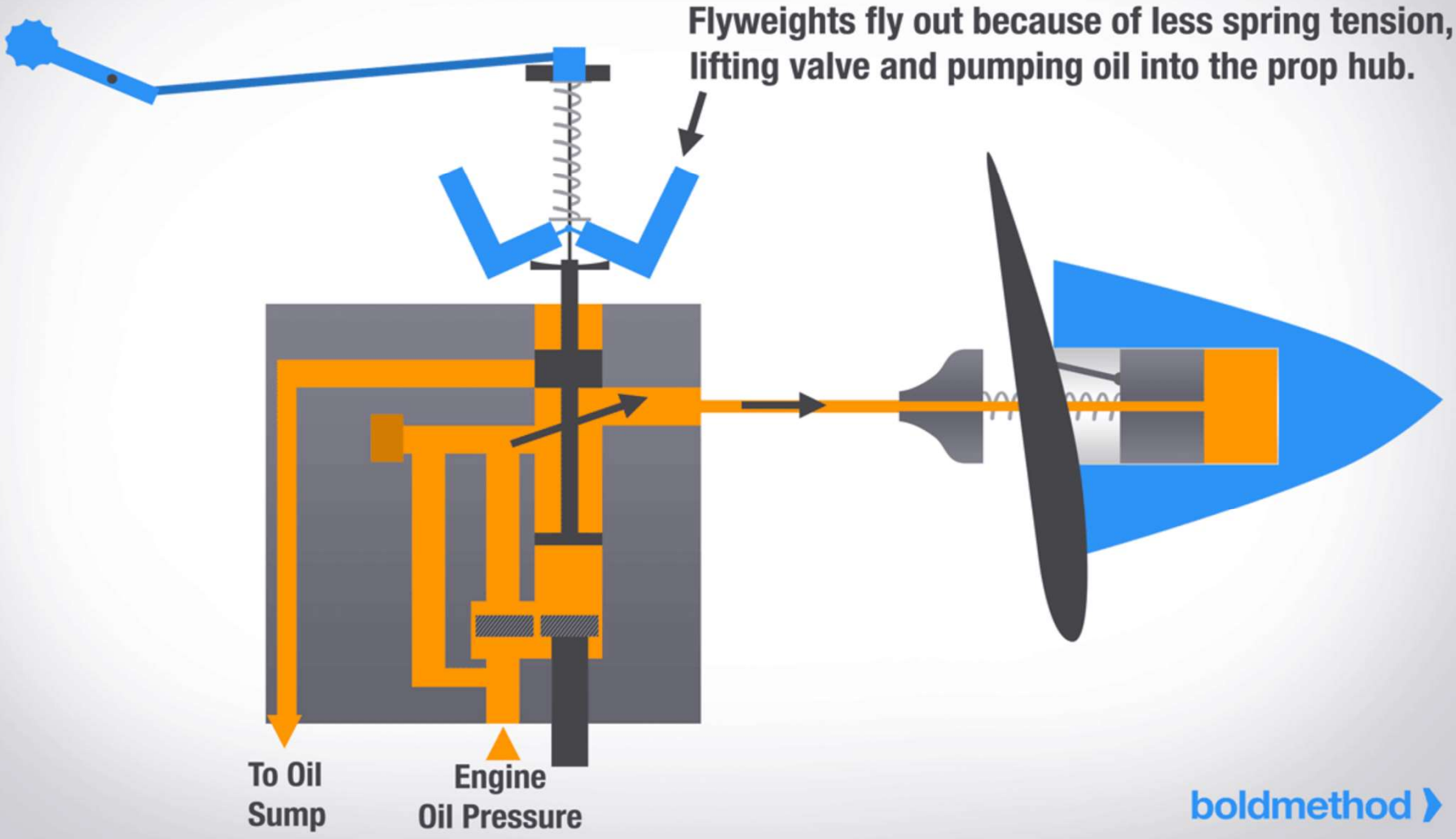

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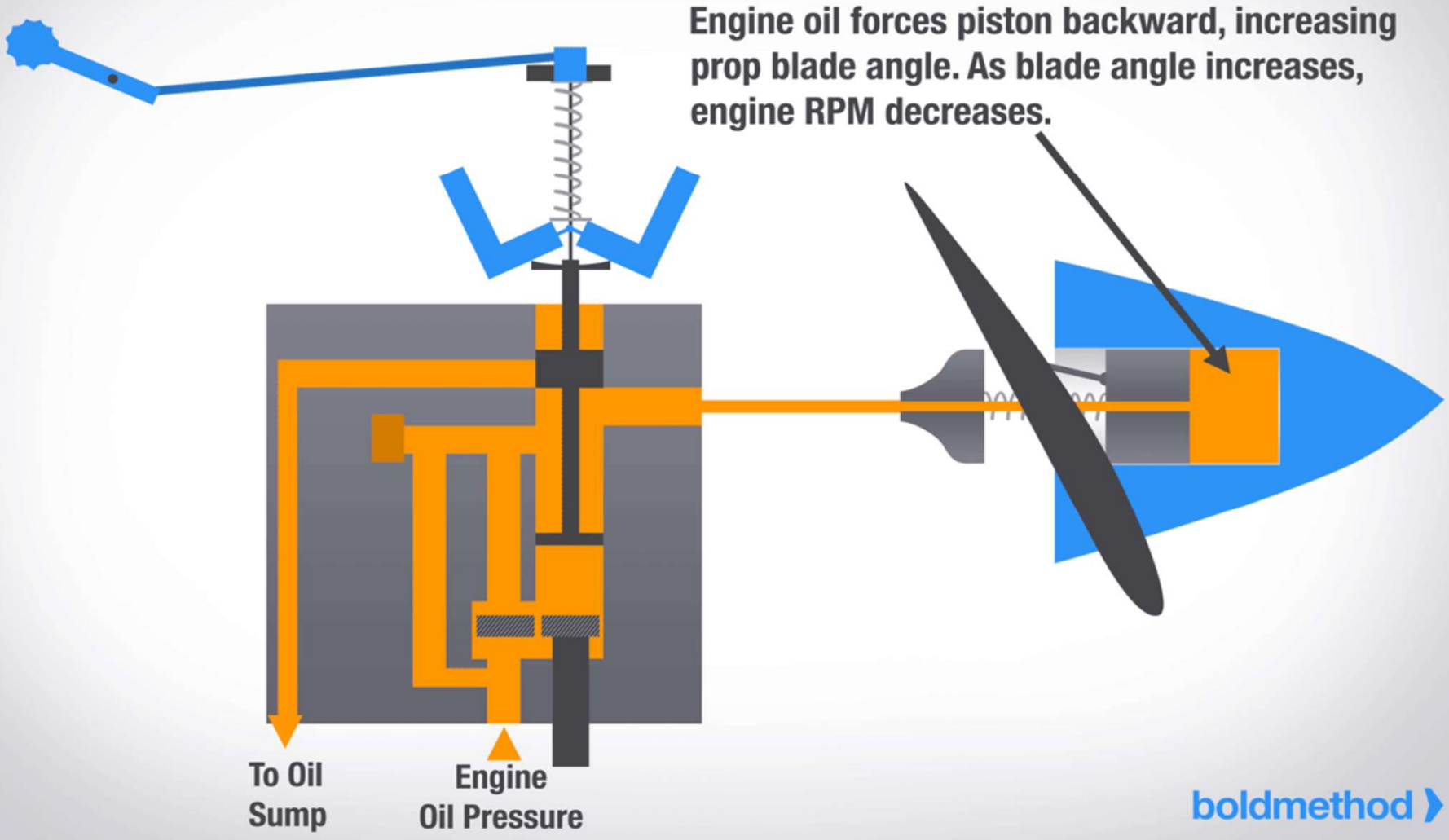

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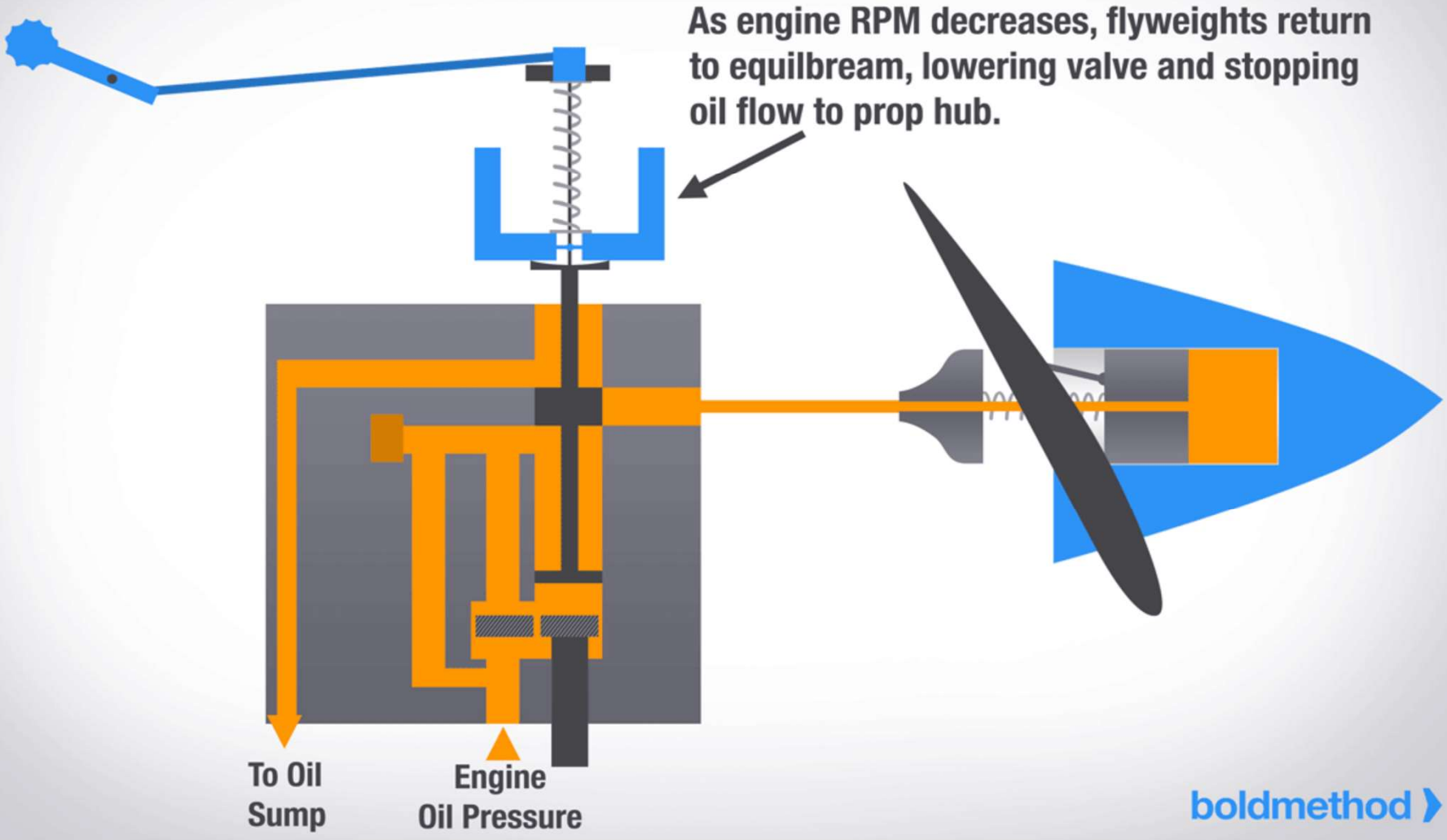

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# Manifold Pressure?

- Constant Speed propeller equipped airplanes have a Manifold Pressure gauge which indicates the potential power output of the engine and is controlled by the throttle.
- “Manifold Pressure” (MP) is just that—a measure of the air pressure in the engine’s intake manifold downstream of the throttle plate.
- Basically, it indicates how much air is available to be combined with fuel in the combustion process.
- Higher Manifold Pressures indicate higher power potential.

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# How Do We Fly This Thing?

## Ground Operations:

- Taxi with the Blue Knob full forward in the low pitch (AoA), high RPM setting (ref: PA-28-236 POH)
- During the Ground Check, move the propeller through its complete range to ensure proper operation. When Blue Knob is pulled back, note a drop in Oil Pressure. Do not allow an RPM drop of more than 500 RPM. (ref: PA-28-236 POH)
- During cold weather the propeller should be cycled Three times to put warm oil into prop hub (ref: PA-28-236 POH)
- Place the Blue Knob full forward to Takeoff. (ref: PA-28-236 POH)

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# How Do We Fly This Thing?

**Climb/Cruise:**

- After you push the throttle full forward for takeoff, don't touch the **THROTTLE**, **PROPELLER** or **MIXTURE** until you've reached a safe altitude.
- Initially, climb with the Propeller full forward in the low pitch (low AoA), high RPM setting (ref: PA-28-236 POH)
- During extended climb operations above 4,000 ft MSL a good technique is to fly 100 KIAS and use 75% rated power by setting 2400 RPM and about 22 inches manifold pressure. (ref: PA-28-236 POH)
- Always consult the Power Setting Table in the POH and/or the Pilot's Sun Visor for cruise manifold, RPM, and fuel flow settings.

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# How Do We Fly This Thing?

**Descent/Approach/Shutdown:**

- During a normal descent, set propeller to 2400 RPM, mixture full rich and power as required. POH Performance tables are based on 137 KIAS. (ref: PA-28-236 POH)
- Accomplishing the “Approach and Landing” checklist, set the propeller full forward to the low pitch setting. (ref: PA-28-236 POH) In this setting maximum power will be available in the event of a Go-Around.
- Prior to Engine Shutdown ensure the propeller is set full forward (low pitch setting.) (ref: PA-28-236 POH)

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# Pro Tips

- The tip for reaching cruise altitude is to first let the airspeed increase after you level off and then decrease power by first pulling the **THROTTLE** back first and then the **PROPELLER** second.
- To increase power it's the opposite: start by moving the **PROPELLER** forward first and then the **THROTTLE** second.
- Most single-engine plane propellers are designed to *'fail forward*', which means that if you run out of engine oil, the propeller will automatically move into the low pitch/high RPM setting.
- It happens for two reasons: 1) the spring behind the prop hub piston forces the piston forward, and 2) the natural twisting moment of the blades moving through the air causes them to return to the low pitch/high RPM takeoff and landing setting.

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# Over Square?

- You've probably been told at some point that flying "over square“ (example:  26” MP, 2300 RPM) can damage that engine.  This is a holdover from days gone by and is generally untrue, although there are operating restrictions that limit certain mp/rpm combinations.

- *ALWAYS consult the Power Setting Table in the POH for power and RPM settings.*

# QUESTIONS