E-25 Timing Indicator Explained: Easy As Pie
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The purpose of the E-25 Timing Indicator is to tell us the location of TDC (top dead center) for the number one cylinder on the compression stroke, a very important landmark in timing a magneto on an aircraft engine. Although not invariably, aircraft engines usually have timing marks to help determine TDC. However those marks can become obliterated or difficult to see. This simple but elegant device uses some elementary geometry to locate TDC irrespective of any external markings on the engine. It is a big improvement over the simple propeller protractor used in the past.

In a nutshell, the device is used like this:

1. Attach E-25 to prop spinner making sure it is on straight and needle is moving freely.
2. Remove spark plug from #1 cylinder and locate the compression stroke by turning the prop while having your finger over the plug hole.
3. Turn prop **backwards** a quarter of a turn and screw the stop pin into spark plug hole.
4. Turn prop **forward** gently until it just touches the stop pin.
5. "Zero" the dial on the E-25.
6. Turn the prop **backwards** until it gently hits the pin again. Take a reading off the dial.
7. Divide reading in half. For example, if it reads 80°, then divide by 2 and reset the dial on the E-25 to 40°.
8. Remove the stop pin and turn the prop **forward** until the dial reads zero or TDC.
9. The #1 cylinder is now at TDC on the compression stroke.

Figure 1 Stop Pin

The one single concept you should glean from this article is this: **When you put a pin in a spark plug hole and stop the travel of the piston/crankshaft/prop going in one direction and then stop it again while turning the prop in the opposite direction, you are defining the complete 360° rotation of the crankshaft MINUS a small <u>arc of denied travel</u>**. Visualize it as a slice of pie of which we do not know the dimensions. Since we are not allowed to measure the slice directly, we will measure the hole left in the pie when it is removed. I have nicknamed this slice the **"arc of denial"** and it is the 80° reading that was measured by the E-25 in the example above. The first time the piston is denied travel it is stopped an unknown (X) amount of degrees from TDC on the upswing (or Before TDC) in the compression stroke. The second time the piston is stopped we are backing up into the exhaust stroke and the pin stops it at the exact location After TDC. Since the piston is stopped in exactly the same place both times, we know that this angle is the same and it is X. Thus, simple logic tells us that the "arc of denial" is made up of two smaller arcs, one on each side of TDC, and both of which have the dimension of X (See diagram). Thus the "arc of denial" is 2X. When we measured the hole in the pie made by this arc and got 80°, we immediately knew that 80 = 2X, so 40 = X. Another way of looking at it is that if the stop pin had not been in the cylinder, we could have turned the prop for 40 more degrees in either direction once it hit the stop and it would have been at TDC, although not in the same stroke.

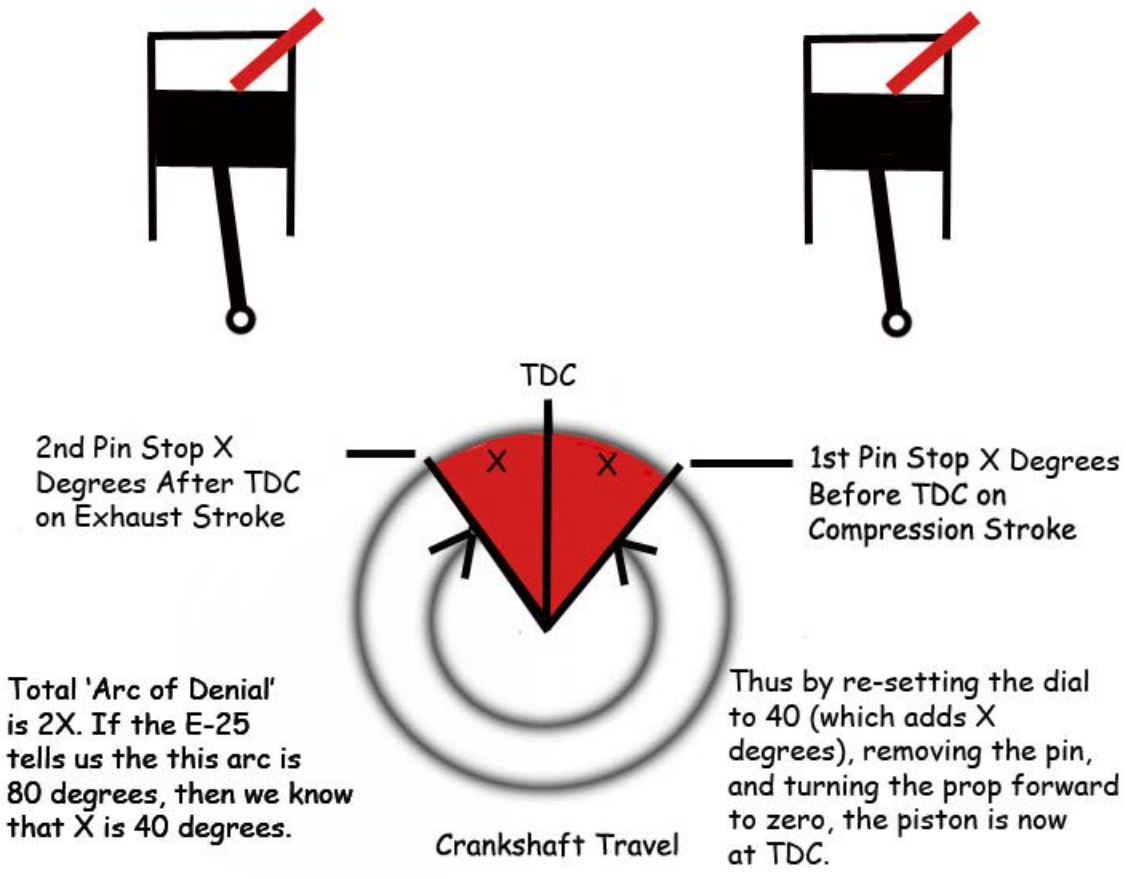

Figure 2 Timing Diagram

Turning our attention back to the mechanics of the E-25, the face on the instrument is laid out so that there is a zero or TDC at the top with markings that read from zero to 180° down each side of the dial. The numbers on the left side represent Before TDC and the numbers on the right are for After TDC. The dial rotates on top of a small aluminum "flower pot" that attaches to the prop spinner with bungee cords. There is friction between the dial and the pot so that the dial normally moves with the prop. We can override the friction on the dial when we need to reset it. The indicator needle swings freely and is weighted so that it is always pointing upward.

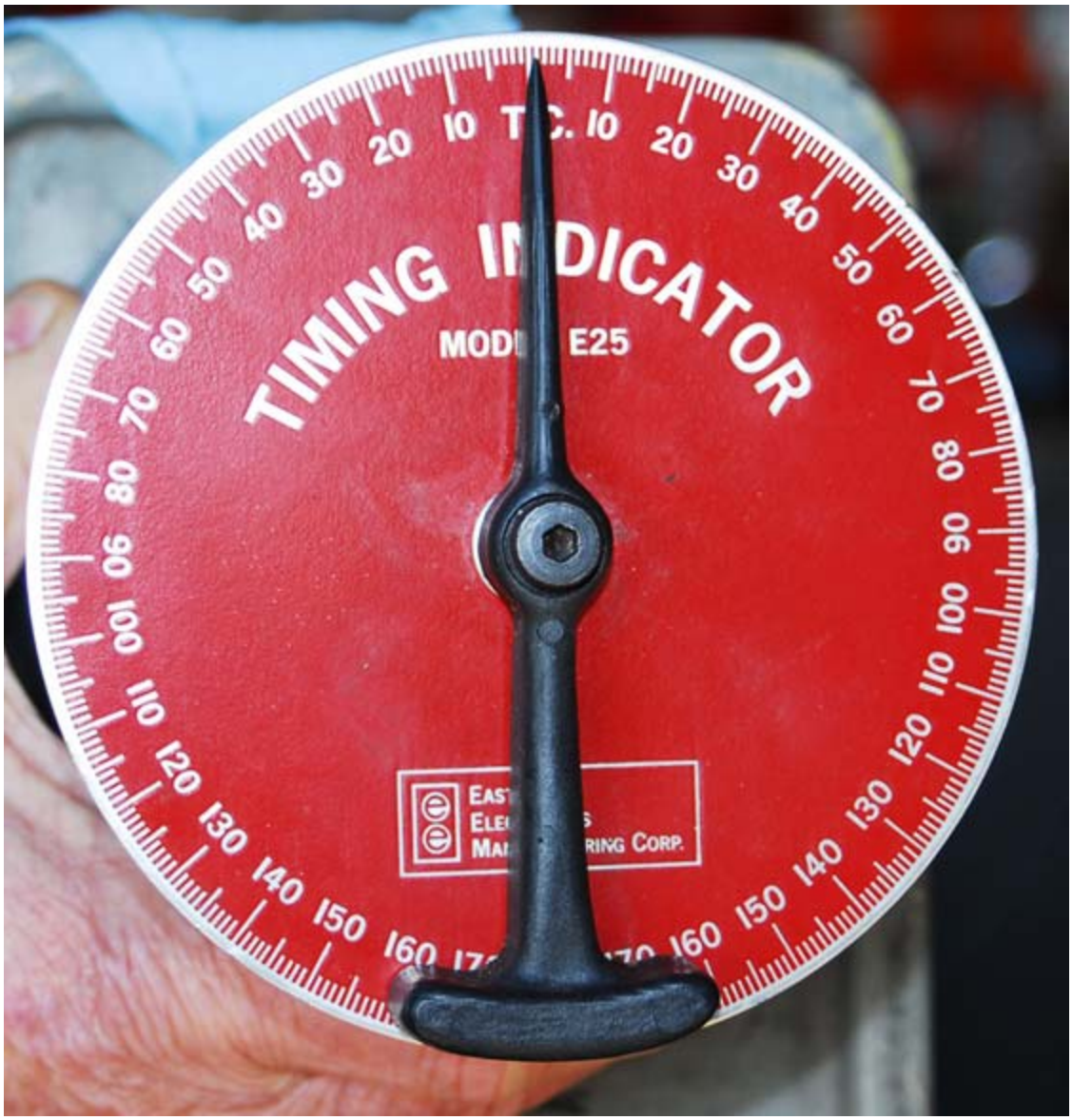

Figure 3 E-25 Timing Indicator

When we insert the stop pin into the spark plug hole, it doesn't matter how long the pin is or how far we screw it in, just so that it can't move. Assuming we know we are in the

compression stroke on #1 cylinder with the E-25 in place, we can turn the prop until it touches the pin. At this point we turn the dial to TDC which "zeros" the device- it does not mean we are at TDC. When we turn the prop **backwards** until the prop is stopped again, the dial is reading the "arc of denial." This is because the ingenious E-25's dial reads **conjugal angles**. (If angle A plus angle B = 360°, then angle A is the conjugal or explementary angle of angle B, or vice versa. Thus if we turned the prop backwards 280° as in our example, the dial reads 80° and saves us doing the math. An added convenience built-in to the E-25 is that by simply dividing the measured arc in two, and then resetting the dial to that new number, we can remove the pin and turn the prop **forward** until the dial reads TDC. In resetting the dial to 40° we were, in effect, adding those unknown X degrees to the travel of the prop on its new forward rotation which took it back to TDC on both the dial and on the piston. Easy as pie.

Technical Editor's Note: The use of any device inserted through the sparkplug hole into the cylinder, which can impede piston movement, should be used with EXTREME caution. Inadvertent piston movement beyond limits will result in very expensive piston and cylinder damage.