Example 1

In trying to remove a nail, a hammer is acted on by a force $F$ of 25 pounds. $F$ acts 7 inches from the head of the hammer. Determine the force exerted on the nail.

**Given:** $F = 25\text{ lb}$, $d_{\text{force}} = 7\text{ in}$, $d_{\text{Nail}} = 1\text{ in}$.

**Find:** $F_{\text{Nail}}$

**Relationships:** $\sum \vec{F} = 0$, $\sum M_p = 0$, $M_p = dF$

**Solution:**

This simple machine can be solved by summing the moments due to the external forces acting on the hammer about the point where the hammer is resting on the table, point $P$. The sum of those moments will equal zero as the hammer is not accelerating; there is no motion, only force, as yet, exerted on the nail.

The force doing the work, $F$, creates a moment about point $P$, as does the force of the nail, $F_{\text{Nail}}$. However, the line of action of the normal force between the hammer and the table, $N$, includes point $P$, so it does not cause a moment about that point.

Thus, remembering to use the right-hand rule for the sign on the moments,

$\sum M_p = 0$\n
$\Rightarrow d_{\text{Nail}}F_{\text{Nail}} - d_{\text{force}}FF = 0$\n
$\Rightarrow (1\text{ in})F_{\text{Nail}} - (7\text{ in})(25\text{ lb}) = 0$\n
$\Rightarrow F_{\text{Nail}} = \frac{(7\text{ in})(25\text{ lb})}{(1\text{ in})} = 175\text{ lb}$\n
$\Rightarrow F_{\text{Nail}} = 175\text{ lb}$
Example 2

You have the given set of pliers; point B is a pinned connection that supports translation forces (e.g., in the x and y directions), but does not resist a moment. 40 lb forces are applied to the pliers as shown. Determine the magnitude of the force exerted on the bolt at A.

Given: \( F_1 = F_2 = 40 \text{ lb} \), pliers are in static equilibrium.

Find: \( F_A \)

Relationships: \( \sum F = 0 \), \( \sum M_p = 0 \)

Solution:

As with many machine problems, they often look scarier than they actually are. The pliers are being squeezed, and you want to determine the amount of force being felt at the bolt.

The first thing to do is break the machine up into parts, and select one to work with initially. Draw up a FBD, and see what forces you can compute from there. If you can't find what you are looking for, move to the next piece. Continue as such until you determine what you need.

I'll start by selecting one of the members.

The fact that point B is a pinned connection means, like a pin in a real set of pliers, it will resist forces that try to slide the members of the pliers apart, but will allow the members to rotate about the pin. So the pin could provide reaction forces on the member we've selected in both the x and y directions, as shown. We will assume the forces are there, and if we need to we can determine their magnitudes, even if they are zero.

After looking briefly at this drawing, by now you should be able to see that if we sum moments about the pin at B, we will have our answer. The forces at B do not cause a moment about the pin, because the pin lies in their line of action. Only the 40 lb force and the force at bolt A (what we are trying to find) cause a moment about B. So sum your moment about B

\[ \sum M_B = 0 \] (remember, static equilibrium)

\[ \Rightarrow d_A F_A - d_{40 \text{ lb}} F = 0 \] (remember, right-hand rule)

\[ \Rightarrow (2 \text{ in}) F_A - (6 \text{ in})(40 \text{ lb}) = 0 \]

\[ \Rightarrow F_A = \frac{(6 \text{ in})(40 \text{ lb})}{2 \text{ in}} = 120 \text{ lb} \Rightarrow F_A = 120 \text{ lb} \]