FAQ of the Month: How Large are the Forces on a Scope Mount?

Rifle scopes are generally held in position on the rifle action by 2 scope rings. The scope rings are designed to hold the scope firmly in place relative to the bore line of the barrel. The scope rings must resist the recoil force of the scope. This recoil force is large and it depends on the weight of the rifle and the weight of the scope.

For example, a 308 hunting rifle has a weight of 7.8 lbs and it is fitted with a scope weighing 1 lb. The force of recoil acting the rifle and scope combined is the chamber pressure multiplied by the cross-sectional area of the bore:

$$60{,}000 \text{ psi} \times 0.074 \text{ in}^2 = 4{,}400 \text{ lbs.}$$

This force accelerates the rifle and scope at a rate of 500 g's. The rings are responsible for accelerating the scope at this rate which requires 500 lbs force (500 g's produces a force 500 times weight of the scope). There are 2 rings and they have to share this force but they do not share it equally.

Another example, a 308 F-Class rifle has a weight of 15.6 lbs and a scope with a weight of 2.6 lbs. The force of recoil is 5300 lbs and the acceleration is 300 g's. This is less than the hunting rifle because the F-Class rifle is twice the weight. But the scope is nearly 3 times the weight of the hunting scope and the force required to hold the scope in position during recoil is 780 lbs.

It is a lot of force and one has to wonder if the rings can provide that force without slipping on the dovetail mount or picatinny rail. Consider the F-Class rifle which has 2 rings that are held in place with ¼" cross bolts torqued to 65 in-lbs. Each bolt would exert a clamping force equal to 1300 lbs. How much resistance to recoil this clamping force can generate depends on the angle of contact with the dovetail or rail and the coefficient of friction. I tested this directly by torquing the ring cross bolt to 65 in-lbs and positioning the cross bolt in the rearward position of the picatinny rail slot. I then delivered a sharp blow with a ½ lb rubber mallet acting through a wooden dowl. The ring moved all the way to the front of the slot. My conclusion is that the rings can move during recoil.

When mounting a scope, we generally move the cross bolt on the front ring of the scope fully forward in the rail slot in anticipation that it will slide forward. But the above suggests that you should also move the rear cross bolt fully forward in the rail slot to avoid having the scope tube resist the movement of the rear scope ring. If the rear scope ring were to slide relative to the front ring it would cause internal stresses in the scope that can affect the reticle position on the target. Even a few 1/1000th of an inch of distortion of a high magnification scope tube can move the reticle by a minute of angle. That may not be significant for a hunting rifle but a minute of angle movement in the point of impact would render a F-Class rifle uncompetitive.

You can learn how sensitive a scope is to distortion of the tube by mounting your scope with a bore sighter in place. Tighten the front cross bolt first and then gradually tighten the rear cross bolt while watching the reticle. Even with high quality rings and rail it will move by 1 moa. For a typical hunting rifle set up the reticle can move 4 moa or more.

~Gordon Holloway