with enviable visual attributes. Even for those with "perfect" vision, moving the front sight farther away helps the shooter more precisely align the sights and always serves to relax the eye.

That's what a tube does, and that's all good. However, it's not (in practice) all good. I probably know as much as anyone about tube advantages and problems, and my quest to pursue the advantages of course meant eliminating the problems.

The primary reason I got away from tubes was that my rifles didn't shoot as well when they were installed. I had several different tubes and one that shot well; only one tube in the half dozen or so I tried would shoot well on every rifle. I determined that the reason it shot well was that it was more concentric of itself and also was better aligned when installed on the rifle barrel (not precisely the same things). I uncovered that by running the tubes in a lathe. The tubes and barrels did not have the same centers. Given that it was from the same maker as all the others I further determined that it was only pure coincidence to have found a "good" one. As a side note, the worst results came with the SR-25. No matter what, that rifle would not shoot with any tube. There had to have been some interaction with vibrations, which may or may not have been via its gas system, because nothing else about the tubes or barrels was any better or worse than on the bolt rifles. When I made my commitment to using that rifle for the time I did I had no choice but to fire it with a barrel-mounted sight. Using the diopters and a 26-inch barrel, I could shoot decent shots but I did not like the sight picture as well as what I saw with a tube.

The runout or alignment problems in the tubes were partly from the materials used and the manufacturing process, and the rest was design. Specifications or selection played a part as well, but overcoming the design and manufacturing problems defined the first, most important step in making the extension tube suitable for championship-level use. These tubes clamped on, and most were a two-piece design (an adapter to clamp on the barrel and then the tube to clamp onto that). There are more opportunities for misalignment in a multi-part system, let alone the runout quality of the tube section itself, and also the stress imparted to the barrel from the clamp. I wondered also about any latent effects from the expansion differences in barrel steel and the aluminum tube components. These extension tubes were first engineered and produced for Smallbore Rifle competitors and have been well proven there, but there's a lot more gas coming from a High Power rifle. As the gas expands within the tube with the bullet still contained within the tube, I think an imbalance can result. I'm not so sure that the cartridge used doesn't influence the effect from a tube: the more gas the more potential for negative effect.

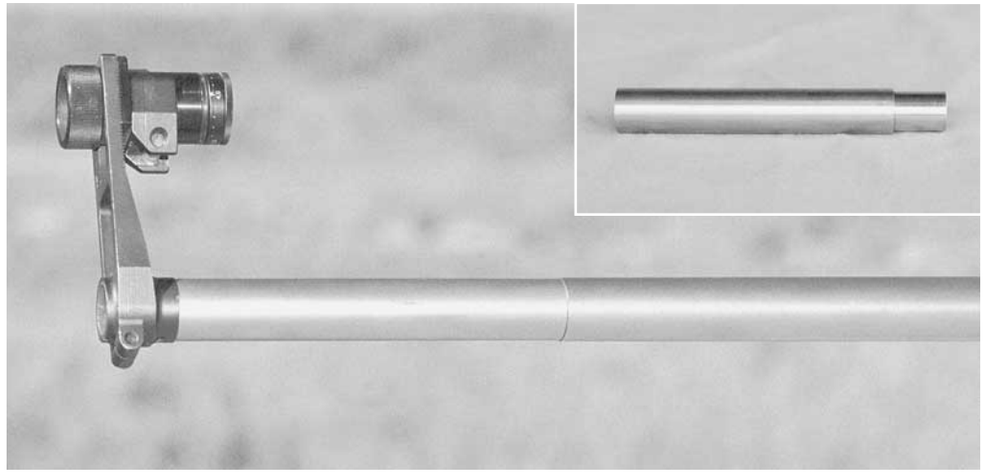
Overcoming the design and construction problems turned out to be easy. I started making my own tubes from barrel steel. I could face and turn the tubes on my lathe, plus I could control outside and inside diameters. I ended up using a .625 inside diameter; that allows a decent wall thickness and yet can be turned to fit the barrel muzzle. Making the outside of the tube right is not the trick, it's the inside. Wall concentricity is an issue, and the tube needs to be reamed and polished on the inside. An aluminum tube will have highs and lows just like a cartridge case wall. Now I had a steel tube that I could hold to within .001 tolerance and also face a square shoulder on it that would match the square shoulder on the turned section at the end of the barrel used to mount the front sight.

I attach my tubes using epoxy and take steps to ensure their alignment and concentricity as the glue is setting up. Done that way there's no stress on the barrel, and the structural epoxy is capable of filling any minute void in the mounting surfaces. The result was, and is, measurably perfect concentricity with the bore. I am hesitant to say that this tube will improve accuracy, but I have seen accuracy improvements in some of my rifles. I have never seen a rifle that shot worse with this tube installed.

I had in the past tried tubes of varying lengths, all the way up to 10-plus inches. I finally settled on a 6-inch tube, which nets approximately a 5-inch extension of the front sight. With a 26-inch barrel, that gives about a 36-inch effective sight-to-sight distance, and that is my "magic number" for a position gun. A prone-only rifle could easily go another three or four inches. I would like to shoot a

SIGHT-LINE

This is my SightLine™ extension tube. I believe this design has overcome all the problems of other styles. I know from machine rest testing that it decidedly does not hurt accuracy, something I cannot say about other extension tube



designs. My tube is made of stainless steel and weighs only four ounces. I use two-part steel epoxy to attach it. There is about an inch and a quarter engagement along the mating surfaces, and it's a snug fit to begin with. The tube butts up against the shoulder on the barrel's parallel .750 diameter section and is then stood vertically while the epoxy cures. Not only is it slid onto the shank of the barrel but it's seated back so it has two square portions to seat itself against. Runout will be less than .005, and that is good.

OLD MULTI-PART TUBE