First or second focal plane reticle:
some pros and cons for each explained.

When I first began servicing binoculars and riflescopes for a living full time back in 1970, after several years of part-time work, there was roughly an equal mix of first and second focal plane design riflescopes being sold in New Zealand.

That was soon to change to an overwhelming ratio in favour of scopes of the second focal plane design. That position remained throughout the next thirty years or so.

Interestingly, today, we are seeing a revival of the preference for first focal plane scopes amongst a small segment of the shooting fraternity.

Here, for those of you who might be interested, are my observations, and thoughts about the shifts in popularity of the two, distinctly different, designs.

Firstly, a simple explanation of the difference.

First focal plane.
Q. What is a focal plane?
A. There are two focal planes in a riflescope. The first one is approximately in line with the two adjusters. The second is about where the eyepiece bell meets the main body tube . These are the two points at which the target image will come into focus. At the first plane, the image is upside down and at the second, it has been reverted to right way up by the erecter group of lenses.

In a scope with the reticle in the first focal plane, the adjusters for windage and elevation bear directly upon the reticle. If the adjusters are moved, the reticle moves. This is why this type of scope is commonly called a reticle-moving scope. With this type of scope, it is common to see the reticle off centre within the view. This is NOT a fault. This is how it is designed to work. In the case of a vari-power model, the off-set of the reticle is often not noticed at the low power setting but becomes increasingly noticeable, (and to some users,

objectionable) as the power is increased towards the highest magnification setting. The reason why it becomes more noticeable is simply that the field of view closes in around the reticle as the magnification is wound up and the offset of the reticle becomes more noticeable.

Another obvious point is that the reticle will increase and decrease in size as the magnification is increased and decreased. What this means is that the reticle will cover exactly the same amount of the target at all magnifications because both the reticle and the image of the target are in front of the erecter lenses which control the magnification. Wherever the target image goes, so does the reticle. More on that when I explain the second focal plane design. This also means that with a multi aiming point type of reticle, the aiming points remain constant at all magnifications, whereas in an image moving scope, they can only be relevant to one magnification.

Finally after the rifle is sighted in, if the off-set of the reticle is found by the owner to be objectionable, then the remedy is to externally adjust the scope to bring the centred reticle closer to the desired point of aim. This can be achieved by the use of scope base shims to raise the front or rear of the scope and by windage adjustable scope mounts. The scope reticle is first brought into the centre of the view and then shims and external windage is applied to bring the line of sight as close to the line of the barrel bore as possible. Thus, only a minimal degree of off-set is necessary when final sighting in is done. This is the reason why, in 1978, I negotiated the distribution rights to Conetrol Scope Mounts for New Zealand. I still consider them to be the best scope mounts made for the widest range of rifles in the world. In their hey-day, Conetrol manufactured around fifteen hundred different bases and I stocked about twelve hundred of them along with the rings in 1" and 26mm sizes. There are even more elaborate and beautifully engineered mounts from Europe but they are for a very limited range of rifles. Sadly, my stocks of rings are now depleted but I have still got a reasonable range of bases blocks available.

Second focal plane.

In a scope with the reticle in the second focal plane, the adjusters bear on a smaller diameter tube within the main body tube. This tube is called the

erecter lens tube and is anchored to the main body tube near the eyepiece by way of a universal joints system, whilst also being controlled by a spring or springs directly in line with the two adjuster screws. It is not correct to say that the adjusters adjust the reticle in this design; rather, they move the image. Hence the term image-moving riflescope.
The rapid rise in popularity of second focal plane scopes is understandable, but sadly, I believe, was borne of ignorance. Let me explain why I say this. Although, as explained above, the remedy for an offset reticle is straightforward, it appears to me that it is not actually that well known or understood in the trade (wordwide). The demand for a scope where the reticle is always centred was quietly accepted by the manufacturers and they obliged by building second focal plane models instead. Most of them got the basics right. The glaring exception was Pecar from Germany who produced the Pecar Champion, so-called image moving model, after years of producing reticle moving models which worked and retained their zero perfectly (the same as my preferred scopes of the time: Kahles). The first Champion model leaked like a sieve! It was a disaster and was replaced by their later attempt at an image moving model which did not leak like their first model, but, instead, would suddenly self-destruct internally because of the way they had gone about trying to correct the leaking problem they had created with the original attempt at an image moving riflescope. If you ever see a Pecar for sale with a circle and a dot within on the reticle saddle and/or the word Champion on the eyepiece, my strong advice is to <u>not</u> buy it. There was another fault with all Pecar riflescopes but that is not relevant to this article's topic so I move on.

The instant appeal of the image moving riflescope is quite understandable. Firstly, you could adjust the windage and elevation anywhere within their limits and the reticle would stay in the centre of the view. Secondly, and even more pleasing to hunters and target shooters alike, was the fact that as you increase the magnification, the target (or animal) increased in size, but, because the reticle did not increase, the reticle would cover less and less of the target as the power increased. This meant that you could select the finest aiming point you needed for each shot.

Those are the two positives which made the image moving design of scopes become the preference of the masses. The negatives have taken roughly a quarter of a century to dawn upon a few shooters and begin a slow return to reticle moving design scopes as the preferred option for some shooters.

Manufacturers of vari-power riflescopes, forced by buyer demand, into building image moving (2nd plane) models, would have realized this simple fact: in order to successfully sell their models they had only to achieve a build-tolerance fine enough to hide the shift of point of impact inherent in the image moving design of riflescope. This simply means that if the average hunting rifle owner's expectation for a three shot group is 1.5 minutes of angle (moa), then all they have to achieve is around 1.5 thousands of an inch build tolerance and their inadequacy is hidden within the overall expectation of the rifle/scope/mounts/ammunition and shooter "package" ability. In later years, their build tolerance has had to be improved because the expectation, for a hunting rifle, moa accuracy has now, reasonably or unreasonably, become to be expected. This perhaps explains the current gradual increase in enquiries for first focal plane scopes from shooters seeking better and more consistent accuracy at longer ranges. Maybe they have found some image moving scopes wanting in the accuracy department because the maker concerned has either not acknowledged, or been able to improve the build tolerances of their scopes.

I alluded earlier to a scope's ability to maintain its point of aim during changes of magnification. I said that the reticle moving design had no problems whatsoever in that regard. I could even state that if you could see around the bend, then you could have an eyepiece on such a scope bent sideways and the scope would still maintain its point of aim. While it would do nothing for its sealing, the scope would still allow accurate shooting.

Not so the image moving models. These models rely for accuracy upon the scope's ability to keep all the moving lenses in the system tracking ABSOLUTELY square one with another along the whole track of the magnification adjustment. I commonly see a shift of point of impact on the collimator when changing magnification on an image moving vari-power.

So too in the case of adjustable objective riflescopes. There are two designs of AO of which I am aware. First is the type where the objective lens rotates and second is less common, where the rotation of the adjuster on the objective bell is changed to a longitudinal movement forwards and backwards inside the objective bell of the scope.
The first system relies upon the optical and mechanical axis of the objective lens being identical, which they mostly are not. The second system could live with an optical error in that department, provided that the fore and aft movement was kept steady and straight throughout the range of its movement. A bit easier to achieve but more costly to build, I suspect.

For those of you who have experienced, with an AO riflescope, the annoyance of carefully zeroing a point of aim at one distance and then, after adjusting out the parallax error at a different distance, have found that the point of impact is left or right up or down from where you expected it to be although still as tight a group size: welcome to the shortcomings of image moving, second focal plane, adjustable objective riflescopes. You may wish to consider joining the queue slowly forming to buy a first focal plane riflescope, despite its shortcomings described above.

Finally, a comment about side-focus models. Side focus achieves the same effect as the AO system. It enables the shooter to eliminate parallax error at any practical shooting distance. The advantage of the side focus is that, when shooting from a rest, you are able to make adjustments while you are visually checking for results. With AO it requires that you take your eye away to be able to reach and adjust the objective, then go back to visually check for progress. Side focus is very much easier to work with. BUT (there always is a but), be aware that the side focus mechanism is much weaker than most shooters would expect in a product designed to accept fearsome g-forces when the rifle is being fired. I have seen far too many scopes with side focus systems which have been broken by the operator. Remember two things if you own such a scope: never wind them too hard or too fast, particularly in cold weather; and never try to wind them past their stops in either direction.

Cheers, Richard.