

CHAPTER 24

BEDDING AND VIBRATIONS

BEDDING

Most smallbore target rifle shooters nowadays use rifles that have fully floating barrels. That means there's no connection between the barrel and the woodwork of the stock, the theory being that the barrel is then allowed to vibrate and recoil completely freely, without hindrance or any stiffening from the stock.

This means that the only connection the barrel has with the stock you're holding is through the receiver (the part of the action which houses the bolt in a bolt-action rifle).

Later *BSA Martini International* rifles work on a different principle, where the forend is constructed around a beam, which cantilevers out from the action underneath the barrel.

The receiver starts out life as a steel tube which has large lumps machined out of it, thereby reducing its overall strength considerably.

This tube of steel is fairly substantial as a piece of metal on its own, e.g. in the *Anschutz Match 54* action the receiver has an overall diameter of 30mm, with a 16mm hole down the middle. This sounds quite substantial, but it has also undergone a fair amount of machining to make way for the bolt and barrel, so instead of weighing 750 grammes, it only weighs about 500 grammes.

This still sounds considerable until you consider that it's trying to support a barrel which is recoiling and vibrating, and weighs some 2,500 grammes - approximately 5 times the weight of the receiver and 3.5 times its length.

If you could clamp the receiver so that it was totally immovable, you wouldn't care how much the barrel moved or vibrated, as it would be consistent, and that's what you're after while you're shooting.

The only inconsistency which could creep in would be the way the barrel is fixed into the receiver.

No rifle manufacturer is going to leave a barrel flopping about in an action, so you can rest assured that, no matter how your barrel is fixed into your receiver, it's as firm as if it was machined out of solid metal with no joint at all, so every vibration of the barrel is transferred *directly* to the receiver.

In most bolt-action rifles the receiver is bolted down to a block of wood (the stock), but in the interests of low barrel lines, the receiver is then let into the wood, which is routed out to receive it.

Consequently, the wood surrounding your receiver is, by comparison, fairly thin and therefore flexible. Most decent target rifles use walnut stocks because walnut has the ability, owing to its molecular structure, to absorb recoil very well.

However, much of that ability can be lost if your receiver isn't connected to the woodwork, and/or the grain isn't true or straight and close.

Choice of woodwork is something you don't normally get when selecting your rifle, but it would be difficult to know what to look for anyway. Therefore, a certain element of luck appears in the equation, i.e. how well does your receiver fit into your woodwork?



The receiver is pulled down into the woodwork with bedding bolts like these

In the bad old days, it wasn't uncommon to find a club member wrestling on the clubroom floor with his rifle and the largest screwdriver he could find, attacking the bedding bolts in an attempt, by tightening them as far as possible, to force the receiver down on to the woodwork to form a solid bed.

That's one way of tackling the problem, but unfortunately it does have its drawbacks.

There have been cases where the stock has been crushed to a dimension the same as the effective length of the bolt; in other words, the bolt has 'bottomed' in the hole and, however hard it's turned, it won't tighten any further on the woodwork.

Increases in humidity and temperature make a wooden stock swell and shrink, thereby altering the tightness of your bolts on the woodwork and, therefore, the tightness of the receiver in the action.

When you fire your rifle you release a considerable amount of *energy*, and that energy is absorbed by you and your rifle. Part of that goes in a twisting motion, because you are forcing a lead slug down a corkscrewed tube with approximately 120 ft. lbs. of energy, but because the bullet is so much lighter than the barrel, the barrel tends to stay where it is and the twisting motion is applied to the bullet.

If the situation was reversed and the barrel was lighter than the bullet, the barrel would be twisted out of its bedding. As it is, you hardly notice any effect at all while you're shooting - all you feel is a small amount of recoil. However, should your barrel be screwed into the receiver, and screwed the wrong way, then you could find it unscrews itself and eventually falls off while you're firing.

Don't worry! Most modern smallbore target rifles are pinned or clamped in place and even if you've had a new barrel fitted and it's screwed rather than pinned, you can be sure it will be screwed the right way round.

Going back to the weight relationship between the barrel and the receiver, if you impart energy to the barrel, some of that energy is going to be transferred to the receiver and there could be a tendency for that twisting motion to want to twist the receiver out of its bedding.

That 120 ft. lbs. of energy is largely dissipated by the time it gets to trying to turn your receiver around in your stock. Nevertheless it *is* still there and, in a stock which isn't bedded to the receiver very well, the only thing which might be stopping the receiver from turning could be the bedding bolts, because they've reached the edge of their holes.

If all you were concerned about was the fit of the receiver into the woodwork, then there's a simple and inexpensive solution to the problem.

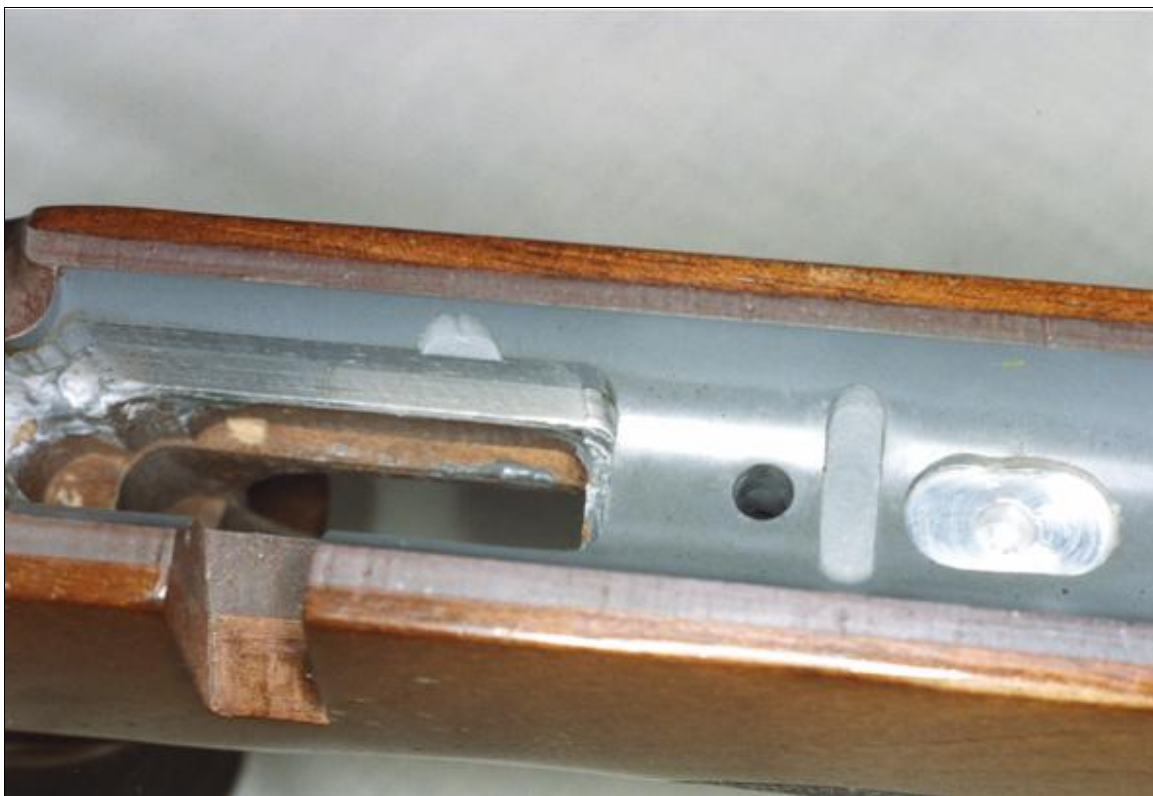
All you need is a thin, soft, malleable substance which, when placed between your receiver and the wood, will squeeze up when the bedding bolts are tightened, and take up all the space between metal and wood, to provide a uniform bed.

Whatever you use must be capable of setting hard, so these new epoxy resins are ideal, although people have used fibreglass and balsa wood soaked in glue. However, don't forget to use a releasing agent on the receiver in case you ever want to remove it from the woodwork.

Well, that solves the problem of wood-to-metal fit, but what about stiffness?

However well the wood fits, it isn't going to add a great deal of stiffness to the action if there isn't very much wood there to start with. So what happens if you rout out more wood underneath the receiver and replace it with an epoxy resin with a metal plate embedded for extra stiffness?

Now you're talking about spending a bit more money, because this sort of major alteration should be left to an expert, but it does kill two birds with one stone: it stiffens and strengthens the receiver and provides a uniform and inert bed.



This epoxy bed also has a metal plate for stiffness

All this may seem unnecessary, but if you try thinking of it in terms of the amount of force which is hammering away at your receiver every time you pull the trigger, then you may be surprised.

The average .22 round produces about 120 ft. lbs. of energy (that's very approximately equivalent to dropping a 12 lb. weight from 10 ft.) so think of the number of times you pull the trigger on a live round - perhaps 5,000 times a year.

If your rifle is, say, 10 years old, simple arithmetic will produce a startling result in terms of the amount of energy, which you've been expecting your rifle to absorb without complaint or movement: in total you're talking about dropping 2500 tons onto it. (Obviously this is a nonsense figure, but remember the impression dripping water makes on a stone over the years.)

By stiffening up the whole area, and improving the joint between wood and metal, you're spreading the load more evenly and removing a weak point in your rifle.

The next question of course is: if it's that good, why don't the manufacturers do it? Principally because it's too expensive, and because they consider it to be the 'icing on the cake', i.e. possibly improving an already splendid product, but *you're* looking for every point, aren't you?

You should be in the business of trying to remove variables in your constant search for improvement, so if you can remove a variable by having your rifle bedded, that might make it worthwhile.

It's not, however, the whole answer - things are never *that* simple in the world of smallbore target shooting.

You can't expect bedding to solve all your problems and suddenly tighten your groups up to 'X Class' standard, as there are other variables closely allied to bedding which, if not tackled at the same time, may reduce its effectiveness.

These all involve the barrel vibrations, the torque settings and selecting the right ammunition; in other words 'fine tuning' your rifle to shoot better groups than its 'out of the box' group.

Having decided that you would like your rifle bedded, the next step is to find a gunsmith to do it for you. The best way of doing this is to examine as many rifles which have already been bedded as possible, and ask their owners who did it and whether they think it was successful.

Some people like more than just the receiver bedded and they go up the first inch or so of the barrel as well. However there may not be any major benefit to be gained from this, as it does remove part of the barrel's ability to be fully floating.

Asking several people how they get on with their particular version will help you to make up your mind but, like most things, the proof of the pudding is in the eating. At least if the bedding's gone too far, it's probably easier to remove it than it is to start adding lumps of epoxy compound to the underside of your barrel.

This would be the time to start experimenting with the torque settings of your bedding bolts, now that you can pull them down onto a nice inert bed which doesn't move, expand or contract with every change in the weather.

First acquire a good accurate torque wrench, either by borrowing one from a club member, or buying one yourself.

Anschutz make one which will be available in your local gunshop, but be warned that it only comes with an allen key fixing, so if you still have screwdriver slots in your bolts, you may need some form of adaptor as well. A British firm called *M.H.H. Engineering* also makes a very nice little torque wrench, which takes normal BRITTOOL bits (readily available in good tool shops).



A torque wrench is essential if you're going to experiment with different settings

As you can imagine, finding the right torque setting for your rifle is a matter of getting down on the range in the best weather conditions you can find, with a well-tried and trusted batch of ammunition, and experimenting until you come up with the tightest groups you can.

Start off with a torque setting of, say, 5 NM (which is what *Anschutz* recommend) and go down by 0.5 NM and see if your group tightens or enlarges. Don't go any lower than 3 NM (you're unlikely to be getting any tighter down there any way, because you run the risk of the bolts vibrating themselves loose). When you've done that, go back to the beginning and go up in 0.5 NM steps.

Keep records!!!

Those of you who are statistically inclined might like to plot a graph of group size against torque setting.

The reason for experimenting with torque settings is because the barrel vibrates; most people are probably prepared to accept that a 660mm long bar of steel 23mm thick, clamped at one end only and then thumped with a considerable force, is going to vibrate. The question is: how much does that affect the group size, if at all?

Undoubtedly it does affect *something* but does that make it more - or less - accurate? To find an answer, first of all you need to go back to basics and decide to what extent the barrel does vibrate.

If you were to clamp one end of a 600mm long steel bar into a substantial metal vice and hit it with a hammer, you would certainly see it vibrate. However, the amount of vibration will depend on where you hit it; for example, if you went for the furthest end from the vice and attacked it in a sideways direction you would see quite a substantial vibration.

However, hitting it with some force at the other end, in line with the long axis, will not produce the same amount of vibration. This may all sound all very obvious to anyone with an Honours Degree in Physics, but everyone else will need to have some conception of what kind of vibration we're dealing with and whether there's any advantage in trying to stop it.

Further experimentation will show that clamping the piece of steel between two pieces of wood reduces the vibration even further, possibly because the wood dampens down some of the vibrations. There's also the possibility that holding the vice in your hand instead of fixing it to a bench (not easy!) may mean that the steel doesn't vibrate at all.

Steel is a relatively elastic material, i.e. it can be bent to a certain extent and it will spring back (unlike lead for example). Just suppose for a moment that your barrel was made of lead and your bullets were made of steel; you would - quite rightly - expect your barrel *not* to vibrate.

However, with a steel barrel and a lead bullet, the ignition from the cartridge slams the bullet forwards into the rifling, which sends stress waves flying up and down the inside of the steel barrel; however, they will be travelling *straight* up and down the length of the barrel.

At the first ignition of the charge in the cartridge, the bullet and case separate and the case is forced back against the bolt face. It's then forced open to seal against the chamber walls, which enables the pressure to mount enough to start driving the bullet down the barrel; all this produces an effect already known to us - recoil.

Recoil acts straight backwards until it meets resistance (i.e. your shoulder); then, because the barrel is above the point where you're holding the stock, the muzzle starts to lift. It is, of course, restrained by your sling, which prevents it from lifting very far, and, as you've no doubt observed through your sights, the barrel very quickly returns to its original line.

If the sling holds it down, the barrel (which isn't attached to the stock at the forend) could move further than the stock. However, as it's fixed at the rear end, the inertia in all that steel may cause it to bend up as it reaches the limit of its upward travel, and then bend further downwards as it returns to its original position.

This could certainly cause a vibration, but is it *after* the bullet has left the muzzle?

As the bullet is only in the barrel for three thousandths of a second, this is distinctly possible (the bullet leaves the muzzle while it's still rising, which is why faster ammunition shoots lower on the target - in most cases).

At the moment of trigger release, when the firing pin smashes into the back of the cartridge case, there is an immediate small vibration set up, dampened slightly by the brass rim absorbing some of the impact as it deforms.

Then there's a very dramatic blow to the back of the rifle, which in a bolt-action rifle, would send the bolt whistling past your ear if it wasn't locked down.

That blow sends stress waves flooding up and down the barrel, which must create vibrations, but are they necessarily going to make the barrel vibrate off its centre line, and if they are, will there be as much sideways movement as vertical?

We know that under recoil the lift and drop of the barrel is not truly vertical - it's more of a little circular movement - but you have to remember that, because the barrel is rifled, the bullet is imparting a twisting motion to the barrel.

So, bearing in mind the earlier comments about vibration being dampened by wood, and the effect if the vice was hand-held, you would expect the vibrations in the barrel to be considerably less because it would be quite free to move after it was hit.

In the case of a target rifle, the *whole thing* moves rather than having one end clamped in an immovable vice, when the barrel has no choice but to bend and, consequently, vibrate.

If you strike a tuning fork, it vibrates with the same frequency (and consequently the same sound) whether you hold it in your hand or on something hard and solid. The solid object just acts as a sound board so you can hear it better.

However, you won't get much of a note out of a tuning fork if you strike it on its end - you have to strike it at right angles to its long axis to get the best effect.

So if you assume that barrels do vibrate you then have to consider what shape that vibration takes.

If the barrel is fixed at one end, that will be a 'node point' (or stationary point), but is that the only node point, or are there others?

There are all sorts of theories regarding how to find other node points (which involve the use of iron filings, flour, steel rings), all working on the basis that, if the barrel snakes up and down, there could be a point which appears stationary.

However, it can be difficult to get your brain around the idea that a one inch thick bar of steel with a little .22 hole down the middle will start snaking up and down, just because it receives a hefty shove at its back end, while being supported by a very soft pliable material (you, the shooter).

It's true that, if you suspend your barrel from something which allows it to move freely, and then gently tap it along its length, it rings like a bell. That's no surprise, of course, as that's exactly what a piece of steel would do. It also vibrates with its own natural frequency, which is dependent on its shape, mass and material. Obviously that's why tuning forks are produced in different sizes for different pitches if they're made of the same material.

It's also true that you may find a point down that barrel where tapping it produces a dead effect - possibly somewhere in the middle - but as soon as you grab the receiver in your hand, the sound goes dead and the vibration stops. Tapping your barrel while it's in the woodwork produces nothing - it sounds dead - which presumably means that the wood is dampening any vibration.

If you accept that a piece of steel held in a vice and then struck, will vibrate, you'll probably also appreciate that the greatest amount of vibration is at the furthest distance from the vice.

If you were to clamp a weight to the furthest end, the vibration would be less if it was struck with the same force, because you've increased the inertia of the steel at that end. That's why *Anschutz* have, in the past, produced barrel weights which clamp to the end of the barrel.

However, not everyone found these beneficial. Some people who tried them out found that, while their groups were noticeably tighter, any errors were exaggerated and the rifle was not as forgiving as it was with its normal heavy barrel.

Undoubtedly if you strike a piece of thin steel rod that has been clamped in a vice, you *can* get it to vibrate in a pattern, which indicates a node or stationary point in the vibration (somewhere about three quarters of the way along the rod). However, there is still an overall vibration, i.e. the rod swaying backwards and forwards under the influence of the force from the blow.

In other words, the stationary point appears to be stationary in one set of vibrations, but the rod still has a movement backwards and forwards.

If you attach a weight to the end of the rod, the rod then bows between its two ends. The weight, together with its own inertia, tends to hold the end still as though it was clamped at both ends. That's all pretty obvious, of course, because it doesn't take a moment's thought to realise that the vice at one end is just a very large weight.

The difficulty with all this theory is understanding *how* it relates to your rifle barrel. Unfortunately, there's very much more to this than meets the eye and there will need to be a considerable amount of constructive thinking and experimentation before sufficient work has been done in this area.

'Bench rest' shooters could lead the way in resolving this question, through their quest for accuracy, but their results don't apply directly to .22 prone or 3-P rifle shooters. Bench rest competitors shoot from a much more stable platform and are less likely to be disturbed by any device which may exaggerate an error.

Do be prepared to experiment, but don't fit something on to your rifle and then assume that you've found the answer to all your troubles, just because you have a few good shoots with it. It doesn't work like that.

If you're adding a weight to your muzzle, for example, first shoot with it on, then shoot with it off; keep a note of your scores in as many different conditions as you can, and see if, at the end of the season, you've actually shot better with it on or off.

World record scores have been shot with a standard barrel, and no accessory is going to make the average club shooter into a world champion. The danger lies in assuming that something works because you've had a couple of good shoots.

It's not unusual to find that someone whose shooting has suddenly fallen down around their ears will take everything off their rifle and start again from scratch - it's the fact that they've *changed* something (and have to increase their concentration to adapt to it) which makes them shoot better, not necessarily the change itself.

Barrel vibrations obviously have some effect - whether good or bad is open to question - but a top-class shooter can probably measure an improvement; further down the classes there is more to be gained from getting the technique right than worrying about how your barrel is flexing.

Another thing to bear in mind is that the bullet travelling down the inside of a barrel does have a tendency to smooth out the vibrations as it goes, like water under pressure down a hosepipe. It's possible, therefore, that the wood, the shooter and the bullet itself are all absorbing and dampening vibrations in the barrel.

A 5mm thick piece of steel vibrates madly when struck, but that's because of the relationship between its length and diameter - a piece 30mm long won't vibrate as much as a piece 1000mm long, because the vibrations die away to nothing very quickly indeed. Therefore, the heavier or thicker your barrel is, the less it vibrates.

If you're really interested in stopping barrel vibrations, you could clamp the forend of your barrel (like *BSA* used to do) and that will dampen everything down, but while you reduce the barrel vibrations you may introduce other problems which manufacturers have tried to cure by producing fully-floating barrels.

If you now accept that our barrels do vibrate, as long as that vibration is constant, its effect on the group size may be negligible, but how do you ensure that it *is* constant?

The driving energy which starts the vibration is obviously the powder igniting in the cartridge case. If that were guaranteed to be constant, it would be reasonable to expect the vibration to be constant. The ammunition manufacturers do their best to work to as close a tolerance as they can, but even *they* can't guarantee perfection every time because of the variation in powder, bullet fit, etc.

It's difficult to see how the ammunition manufacturers can make any major improvements in the consistency of their ammunition, apart from manufacturing under laboratory conditions, but then nobody could produce it fast enough to keep up with the rate at which the shooters would use it.

Eley, for example, make approximately 30 batches of *Tenex* a week, at around 25,000 rounds per batch - that's a staggering three quarters of a million rounds of *Tenex* every week, or 39 million a year. They wouldn't make that much if it wasn't being sold.

So we're going to have to accept for a while yet that ammunition is a variable, and, therefore its effect on our barrels is going to vary.

So far we've come to the conclusion that our barrels vibrate and by a different amount with each shot, but how do we minimise the vibration?

Most rifle manufacturers these days fit fully-floating barrels onto their rifles; that means that the barrel is only fixed at one end (usually the breech end), which allows the barrel to float freely when a round is fired.

The manufacturers are unlikely to have chosen that path lightly and you can probably rest assured that, if one manufacturer had devised a system of making his rifles more accurate than anyone else's, all the others would have followed suit very quickly.



Some manufacturers have gone for big heavy square receivers to help dampen movement

However, just to throw a spanner in the works, *BSA* went to a fully-floating barrel when they produced the *Mark III*, but in the *Mark IV* and *Mark V* the forend is fixed to the barrel, not the receiver.

Some manufacturers of early target rifles produced devices fixed to their barrels, which were designed to 'tune' the barrel to a particular batch of ammunition. Like a lot of ideas, that's fine in theory but, in practice, if you get it wrong it tends to make things worse, and there's much more scope for error than there is for hitting just the right spot.

There have been all sorts of experiments carried out in an attempt to alter or stabilise the vibrations of .22 barrels; people have packed a variety of materials between their forend and barrel - anything from foam rubber to bath sealant.

Anything put between the barrel and the forend will certainly have an effect on the vibrations. However, this *could* be a detrimental effect, firstly because the barrel *must* vibrate both up and down, so anything placed under the barrel will reduce or dampen its downward movement while leaving it free to vibrate upwards. That could produce an off-balance vibration, which theoretically doesn't seem right.

Secondly, any substance you put under your barrel creates another variation because various materials change their consistency over a period of time. Foam rubber breaks down and loses its elasticity, bath sealant can go hard and crumble - are you going to hope that what worked initially will still work two years later, or how are you going to decide at what point you need to renew it?

You could, of course, just screw your forend to your barrel like they used to, but that would appear to be flying in the face of the manufacturers' experiences.

Sporting rifles with floating barrels won't shoot straight if the foreend wood is touching the barrel anywhere. Sporting rifles, of course, have much lighter barrels which will vibrate more, and may show a more dramatic effect than the heavyweight target barrels.

One obvious way of reducing barrel vibration is to shorten the barrel. Malcolm Cooper shot a *Walther* with a shortened barrel for some time, and now *Anschutz* have produced a rifle with a very short barrel (the 20...series); the theory is that shortening the barrel but retaining its thickness stiffens it considerably, which will in turn reduce the vibrations.

Lots of people equate length of barrel with accuracy and wrongly assume that a longer barrel is more accurate, simply because they remember John Wayne reaching for his rifle if he had to shoot an Indian more than 10 yards away. However, although rifles *can* be shot more accurately than pistols, that's not because of the actual length of the barrel, but more because of the length of the sight radius and the way the rifle is held.

Therefore, although *Anschutz* have dramatically reduced the length of their latest barrels, they've maintained the sight radius by means of a tube at the end; however, the importance of sight radius is discussed elsewhere.

Provided the barrel is long enough to ensure that all the powder is burned before the bullet exits it, that is sufficient; with the average subsonic rifle round about 375mm is enough; if you add a small safety margin you could say "who needs a barrel longer than 450mm?"

Many of you will probably remember twanging your rulers on the edge of the school desk when the teacher wasn't looking. Do you remember the different sounds that could be made by altering the length and the way you held the ruler? Keep that idea in your head when considering torque settings and bedding.

Those of you who shoot *BSA* rifles won't find this bit particularly interesting but you might be interested if anybody has been able to create a variation in their group size by any experiments with stock tightness. However, whatever you do, *don't* loosen the bolts clamping the barrel into the receiver.

Now, those of you with *Anschutz* rifles may be interested in the results of some very thorough trials carried out by Mr P.J. Andrews of Bedford involving variations in the torque settings of his bedding bolts.



The difference a torque setting can make

There is obviously a relationship between the torque setting and the group size, which is something most of you have realised and tried out for yourselves. For his experiments, the rear bedding screw was set to 5NM and the front one was varied, producing the results shown above.

The groups were shot from the shoulder with a standard *Anschutz 1813*, in as near perfect conditions as can be arranged in this country: you can probably see from the results that the more the front bedding bolt was done up, the more the groups tightened.

It's possible that the groups may continue to shrink if the torque is tightened further but, on the other hand, they may start to open out again. Also, if the back bedding bolt were to be altered, that may produce an entirely different set of results. The only way to prove the case for your particular rifle is to do the experiments yourself and log the results.

Those of you who are habitual ruler twangers will have already made the connection between the change in note of a vibrating ruler and the pressure with which you held it on the edge of your desk. Now you're probably making the same mental connections with the results shown above.

You could be right or you could be wrong. The tightening bedding bolts could be damping down the vibrations; on the other hand they could just be tuning the vibrations to suit that particular batch of ammunition. What is obvious is that the torque setting can have a dramatic effect.

