**Steel shot: what you need to know. Part 3**

# Choke 'Bounce' With Steel Shot

***Picture 1: Steel pellet 'Bounce'.***

When it comes to chokes with lead shot cartridges, there are few more contentious subjects at the shooting stand than the best option for a particular type of target. With steel shot things take on a different twist, as there are many other issues at stake, apart from the straightforward control of the pattern spread. Initially there are choke constriction limits (expressed by the UK Proof House), that recommend maximum degrees of choke when using steel pellet cartridges in ordinary shotguns designed for lead shot; the idea being to prevent accidental gun damage or shooter injury.

There are some who consider that the smaller steel pellet sizes (as used in clay pigeon cartridges), are not really a problem when used with tighter chokes than those stated by the Proof House. But if these safety issues are put to one side, there are far more profound reasons why tight chokes are not a good idea when using steel shot. When steel shot was first tried out in the USA, it was fired through full choke barrels, just as the lead shot had been before, but it patterned both badly and extremely erratically. This also over-stressed the metal at the choke, leading to metal fatigue problems and outright failures, resulting in permanent gun damage.

It was later found that the degree of choke had to be drastically reduced to retain reasonable downrange patterning. High speed photography also showed that the new steel pellets behaved differently when they exited a tighter choke; the front pellets appeared to bounce out of the choke, at a much higher speed than the main part of the shot charge. So following on logically from steel pellet ricochets in part two, part three of this series explores the steel pellet choke '*Bounce*' phenomenon and what chokes are needed for steel shot.

Steel pellet *'Bounce'* can occur at the choke or any other constriction within the barrel, akin to an internal ricochet of sorts within the confines of the barrel, together with its attendant effects of wide velocity variations and greatly lengthened shot strings.

The very hardest types of lead shot pellets can also be *'Bounced'* at the choke, but to a greatly reduced extent, due to their very limited elastic qualities. Steel shot pellets on the other hand, are extremely susceptible to this *'Bounce'* effect. They posses an ideal combination of both hardness and limited resilient elasticity, it is this latter elastic property*, that lends itself to the optimum transfer of energy to other pellets.

***Literally the ability to bounce back into shape after experiencing a compressive force capable of distorting them, but not sufficient to do so permanently.**

This can be from the rear pellets through to the front ones and also the lateral (sideways) 'Bounce', as they leave an overly tight choke constriction that has compressed them too much.

## Surprising test results

After conducting large numbers of tests and experiments with steel shot over a ten-year period, unusual things were encountered. These phenomena were first discovered when test-firing steel shot cartridges for velocity, whilst also simultaneously testing each shot for pattern.

The steel shot test was conducted as a 'control'*, being part of a confidential project to establish the relative patterning ability of a newly developed, high-density, non-toxic shot pellet, when compared with steel.

***'Control' in this case means the establishment of a set of data so that comparisons with the new pellet could be readily made.**

The gun used was a12bore with a 2,3/4inch chamber with and a fairly tight 'Modified' choke installed, (20 thousandths of an inch constriction which is a maximum amount for a UK half choke in a 12bore) and a considerable number of shots (25) were fired from a fixed rested position. This was to ensure accurate shot placement and establish a reasonable average, to effectively judge their performance capabilities.

Within these 25 shots, three of them displayed very large velocity increases (200 – 300feet per second) when compared to the others. Six other shots were also faster than the average of the others, although not to the same extent, but all of them displayed varying degrees of wild and erratic patterning.

The visible pattern centres of the pellet marks were also wildly variable, being higher, lower, or to either side of the aiming point, displaying a variable shift in the point of impact of the pattern.

Pellet drop due to gravity could not explain this even for the lower shots, as at 40yards range, the 2.4mm steel shot used would drop by less than four inches, not at all sufficient to display such wide variations.

There was also no obviously noticeable difference in the report of each much faster shot, (which would normally occur with a significantly higher velocity loading), so this was indeed perplexing.

To eliminate any effects caused by the choke it was changed to a true cylinder, (with no choke constriction) and the test was performed again. The average velocity was still more variable than with lead shot cartridges, but this time, the occasional wild high-speed readings did not occur. The patterns were also much more consistent and evenly distributed — the 20thousandths of an inch of choke constriction was causing both of these effects.

As it later transpired, two aspects of the '*Bounce'* factor had been inadvertently discovered, but the full implications were yet to be established. The amount of choke was clearly having an effect, but when using choke with steel shot it pays to consider its origins. Choke was created to control the initial excessive spread of very soft lead shot pellets, much softer than that available today. Being much softer than the barrel wall, these lead pellets were incapable of causing barrel damage by squeezing contact, even with the usual Full choke muzzle constrictions.

**The choke constriction factor**

Before going into the details of the *'Bounce'* effects, the choke limits for steel shot must be considered. There are recommendations by the C.I.P proof authority as to the maximum amount of choke best used with steel shot pellets with ordinary shotguns, which is half choke (USA 'Modified'). These are primarily meant as a safety measure, but if this safety aspect is set aside, in reality, using greater amounts of choke, (or even the maximum recommended half choke), is often not an effective way of controlling the pattern. A serious mechanical problem with excessive choke is the relative non-compressibility of the steel shot pellets, when compared with lead.


***Picture 2: In the USA the choke requirements for steel shot are well known, and they are clearly marked to differentiate between their intended uses for steel and lead shot. This full choke tube is distinctly marked LEAD SHOT ONLY.***

The use of robustly constructed plastic wads with deep shot cups that entirely contain the steel shot pellets is the ideal scenario, as some of the squeezing at the choke can be absorbed by the yielding plastic material. Excessive degrees of choke constriction, can go beyond the shot cup's capabilities of lateral pressure absorption and transmit higher stresses, to both the metal of the choke tube and the muzzle, as well as compressing the steel pellets to, or even beyond their elastic limits.

If these elastic limits are exceeded, it means that a greater lateral pressure is put upon the muzzle end of the barrels, perhaps more than they can comfortably withstand. This tends to cause bulging if this pressure is beyond the elastic limits of the metal (it's ability to bounce back into shape again); so instead it literally wants to make the hole at the end of the barrel larger, until it has been widened to a tolerable level.
Another more subtle effect is that of bulges caused by an internal pressure wave, being set up when the choke slows the shot charge to an excessive degree. This can act like a blockage at the end of the barrel, forming a 'ring bulge' around its circumference, or even burst it open in some cases.

Typical shotgun pellets, as found in budget club level fibre wadded cartridges, tend to contain the softer alloy types of lead shot. Their elastic properties are extremely limited and subsequently they do not 'Bounce' very well, tending instead to permanently distort, when they are subject to either the compressive forces of rapid acceleration in the shotgun chamber, chamber cone or the choke, or when they strike an object.

***Picture 3. The lead shot used in club fibre wadded loads has very limited 'Bounce' capability.***

There are two main aspects of this '*Bounce*' effect. The first one is an accelerative '*Bounce*'; being concerned with the acceleration of the front pellets up to much higher speeds than the main part of the shot charge. The second one, is the lateral 'Bounce', that can expand the overall pattern spread rather more than would normally be expected with the degree of choke used.

Steel pellet 'Bounce' can also occur after the shot has left the barrel at close ranges and not been able to spread out to a significant degree. After the steel pellets in the front of the shot string have impacted their target and been slowed down, the rearward pellets can run into them. When this occurs, all of the pellets can have their speed and direction altered (by ricocheting), when they run into each other.

***Picture 4. Steel shot pellets are many times harder than lead and possess a degree of elasticity that makes them nigh on perfect for 'Bounce' phenomena to occur.***

***The relatively thin plastic shot cup walls of this wad, will transmit progressively higher lateral compression pressure to the steel shot pellets it contains, as the tightness of the choke increases beyond the optimum for these particular components.***

***Picture 5: a 'Newton's Cradle', which was originally created to demonstrate the priciple of Sir Isaac Newton's second law. 'To every action there is an equal and opposite reaction'***

***These items  are quite popular as desk top excecutive toys, but they can also be utilised to demonstate the principle of the 'Bounce' effect on steel shotgun pellets.***

A 'Newton's Cradle' can show the energy transfer and resultant variable velocity effects of steel spheres (balls) when they impact against (and transfer energy through) each other in a variety of scenarios.

Steel is an almost perfect material to demonstrate these effects, as it posses both the right amount of hardness and elasticity, giving it the ability to '*Bounce*' well.

Figures 1, 2, 3 and 4 show how energy can be transferred through steel balls of the 'Newton's Cradle'.  It is this general concept of energy being preserved and transferred through steel balls, that is the root of the types of 'Bounce 'effect encountered with steel shot pellets.

Figure 5 shows what can happen at the muzzle with excessive choke constriction using steel shot pellets.

***Demonstrating 'Bounce' with a Newton's Cradle with the five steel balls are arranged and suspended as in the main picture number 5.***

*The following figures will show that varying degrees of energy can be transmitted through steel pellets from the rear or released when the sideways squeezing pressure on the pellets is excessive at the choke*

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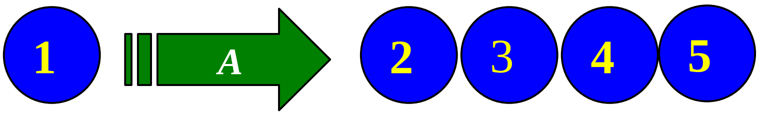
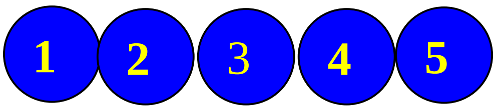
## *Figure 1. Single 'Bounce'*

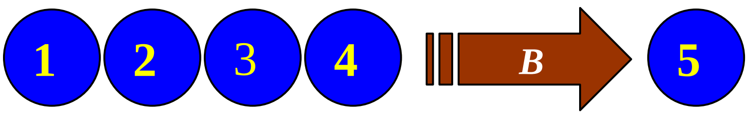
*The most basic demonstration of this principle is if the single end steel ball number 1 is pulled and lifted away the others, and then released when it travels in the direction of the green arrow (A).*




*When steel ball number 1 impacts with steel ball number 2 it appears to come to a stop.*



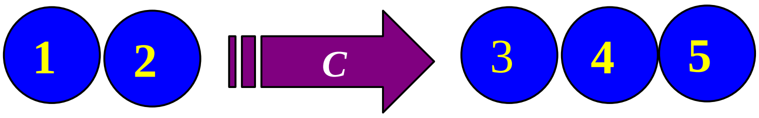

*But at the same time steel ball number 5 at the opposite end, flies outwards in the direction of the brown arrow B at the virtually the same rate, having been 'bounced' away.*



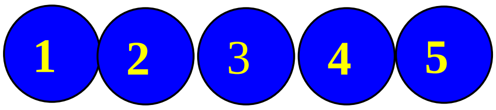

*The energy of steel ball number 1 is transferred through steel ball numbers 2, 3 and 4 and ultimately to steel ball number 5, which is then propelled away from the others, by the energy originally transferred from steel ball number 1.*

## *Figure 2. Double 'Bounce'*

*When steel ball numbers 1 and 2 are lifted away and then released in the direction of the purple arrow C, so that they impact with the steel ball numbers 3,4 and 5.*




*Steel ball numbers 1 and 2 then appear to stop.*



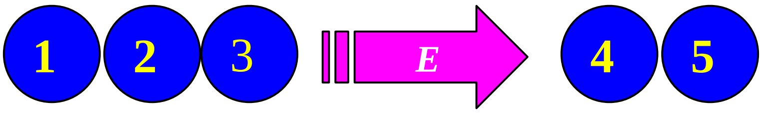

*Steel ball numbers 4 and 5 at the opposite end move then away at a similar speed (in the direction of the orange arrow D).*


*This demonstrates that the energy of steel balls 1 and 2 has been transmitted through steel ball number 3 to steel ball numbers 4 and 5.*

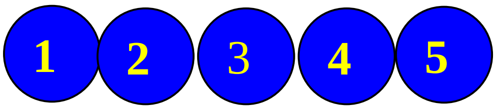
## *Figure 3. Treble 'Bounce'*

*When three balls are involved, things get more complicated and perhaps the energy transfer between the balls becomes rather more interesting visually.*

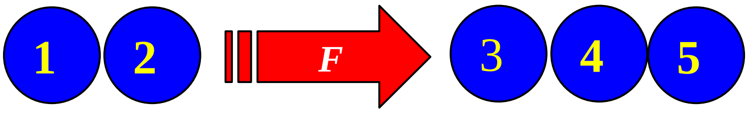
*Steel ball numbers 1, 2and 3 are lifted away and then released in the direction of the pink arrow E.*




*When they impact with steel ball numbers 4 and 5, only steel ball numbers 1 and 2 appear to stop.*




*Steel ball number 3 appears to continue its movement, but it now does so in conjunction with steel ball numbers 4 and 5, moving away at a similar speed in the direction of the red arrow F.*




*This demonstrates that although the energy of steel balls 1 and 2 has been transmitted through steel ball number 3, to steel ball numbers 4 and 5, the energy of steel ball number 3 is also retained, which is why it also moves away.*

*But this time it does so with steel ball numbers 4 and 5 in the direction of the red arrow F.*

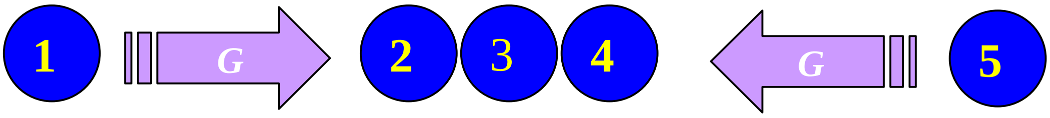
*In figures 1, 2, and 3 varying amounts of energy are shown being transferred through to the balls at the opposite end of the stack.*

*The precise stacking arrangements of the steel pellets will have an effect on the actual amount of energy that is transferred into a higher velocity of the front pellets. The straighter the stacking, the faster will be the imparted velocity. With more crooked pellet stacks, the transferred energy is still there, but instead, some of it is transferred into sideways thrust against the choke walls and other pellets.*

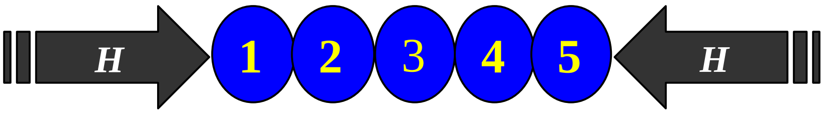
*This is similar in its effect to the additional thrust transmitted to the pellets at the front of a steel shot charge by varying degrees of excessively tight chokes.*

***Figure 4. Lateral 'Bounce'***

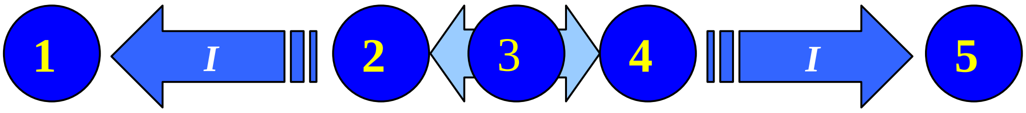
*Steel ball numbers 1 and 5 are lifted an identical distance away from the remaining central pack containing steel ball numbers 2, 3 and 4. When released, they travel in the direction of the violet arrows G.*




*When both steel ball numbers 1 and 5 impact with the central pack of steel ball numbers 2, 3 & 4, it has (albeit very briefly) a similar effect to steel shot being squashed sideways and distorted at a tight choke, which is represented by the dark grey arrows H.*




*The energy of the steel ball numbers 1 and 5 cannot be lost, but has briefly been absorbed by the elasticity of the pack of five now temporarily distorted steel balls (exaggerated in this image for clarity).*




*The energy is then released, with the outward movement of both steel ball numbers 1 and 5, in the direction of the blue arrows I. Steel ball numbers 2 and 3 can be seen to bounce outward from both sides of the central steel ball number 3 (double ended light blue arrow). They respectively do so in the same direction of the blue arrows as steel ball numbers 1 and 5.*

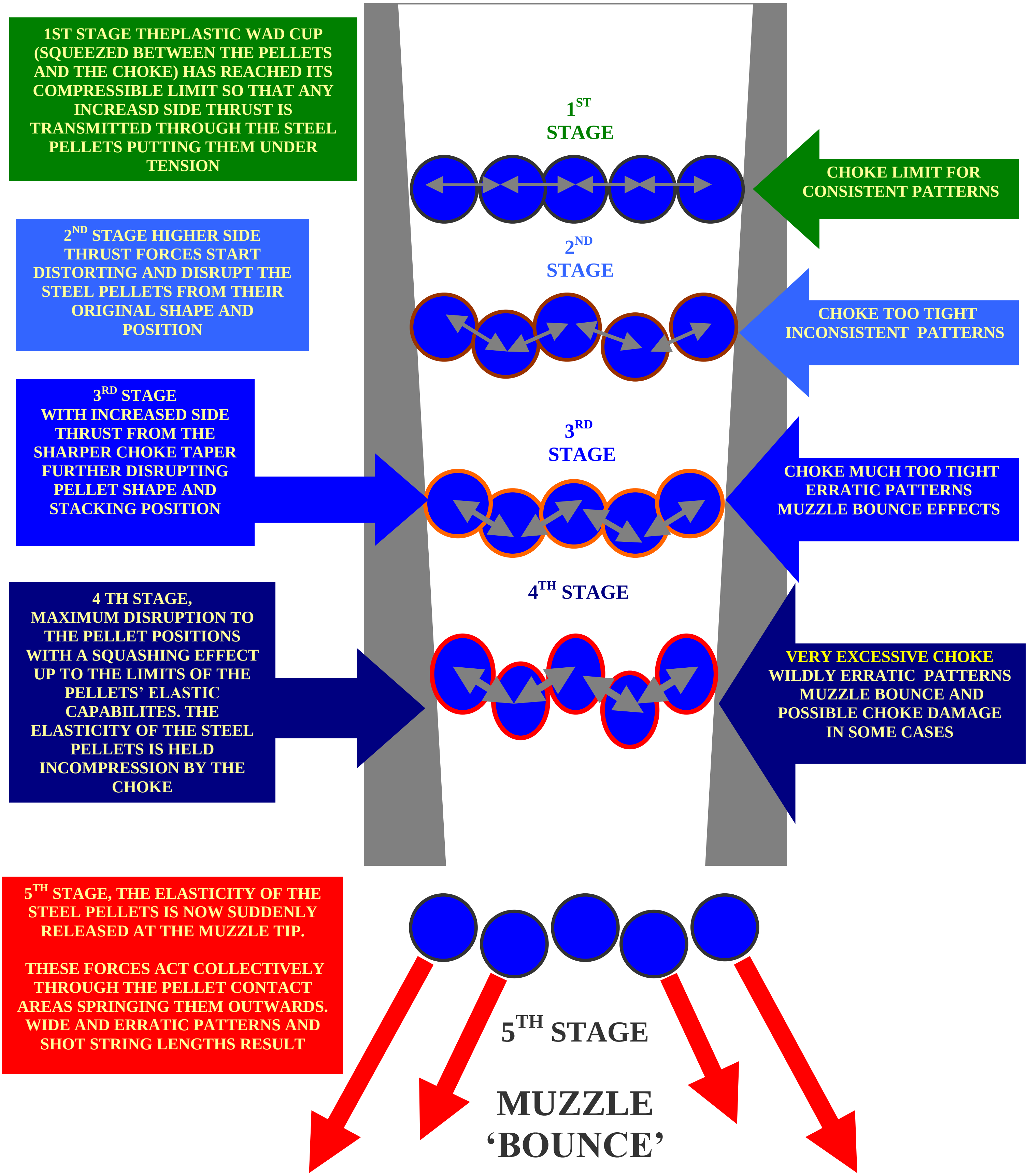
*This release of the compressive pressure shown in figure 4 (like the effects of an excessive amount of choke with perfectly aligned steel pellets), has caused all of the steel balls to expand and move outwards to varying degrees where possible; misalignment of the steel pellets at the choke causes other problems.*

*Figure 5 shows a full-length image of the progressively distorting and squashing effects of an excessive choke constriction upon the steel pellets, causing their uneven stacking within the bore diameter.*

*The sideways thrust as they exit the muzzle is caused by the release of the energy in the distorted pellets by the compressive force.*

**Figure 5**

## STEEL PELLET MUZZLE 'BOUNCE' EFFECT WITH EXCESSIVE CHOKE CONSTRICTION (THE PLASTIC WAD CUP IS NOT SHOWN)



**Accelerative *'Bounce'***

Accelerative '*Bounce*' is created when the wad and the forward portion of a steel shot charge is slowed by a change in the bore diameter, such as might be found with a tight choke. When this happens, some of the energy possessed by the rearward steel pellets can be transferred through the main body of the shot charge to those at the front, accelerating them away from their position in the wad cup to a higher velocity than the others.

The constriction at the choke has a braking effect and slows down the leading pellets, but those in the rear are still being propelled by the expanding powder gases, and transmit this force into and through the length of the steel pellet stack. These effects are demonstrated in figures 1,2 and 3.

Newton's law ensures that the net result of all of this activity, can be a considerably raised velocity of the leading pellets, by as much as 200 to 300 feet per second when compared with the central part of the steel shot cloud. The actual velocity gain has been found to vary considerably with many pertinent factors.

Some of these factors are listed as follows: the steel pellet size, the arrangement of the pellet stack in the wad cup, the length of the shot column, the design and thickness of the plastic wad cup, the length and angle of the choke taper, the actual amount of choke constriction, as well as the velocity and residual pressure from the burning powder gases at this point in the barrel.

**Lateral *'Bounce'***

Lateral 'Bounce' is when the compression of the steel pellets is so great by an excessively tight choke that they literally bounce outwards when leaving the muzzle. Generally the greater the excess of choke constriction, the worse that this lateral bouncing problem becomes. The best patterning consistency with steel pellets is to be had with the least amount of choke possible for the task at hand.

The same factors listed that cause 'accelerative bounce' can also have a direct bearing on the patterning potential of any given combination of choke, velocity, pressure and wadding components.

**Choke choices for steel shot**

As a general rule of thumb it is best not to exceed half choke (Modified in the USA), but often the best patterns (with steel target loads) are to be had with considerably less choke constriction than this.


***Picture 6. A Modified choke for Lead shot (Half in the UK) is the maximum recommended for steel shot (giving a Full choke pattern), but as clearly indicated, greater degrees of choke are simply not needed with steel pellets. The CYL- LEAD (true cylinder) choke throws around a USA Imp/Cyl (UK quarter choke pattern) with steel shot.***

It is never really necessary to use anything more than a 'true cylinder' choke, (with no muzzle constriction whatsoever) when shooting Skeet targets, as even a 'true cylinder' choke can give something like a quarter choke (USA IMP/CYL equivalent) pattern when using steel shot. A USA rated 'Skeet' choke has about the same amount of constriction as a UK Improved Cylinder (somewhere around 3 - 5 thousandths of an inch), and will generally throw much tighter patterns (somewhere around 1/3 choke, between a UK rated quarter and a half) with steel shot, than are to the Skeet shooter's advantage.

For sporting clays (in the very limited places and shooting stands where steel shot can be used in safety), a Skeet type choke or at most a UK quarter equivalent, (USA IMP/CYL) is about the tightest choke that is needed. These usually deliver a 1/3 to a half choke pattern with steel, which is plenty for shots at the limit of the steel shots' target breaking range.

For sporting targets at the relatively close and at best medium ranges (where steel can possibly be effective), a true cylinder choke seems to work perfectly well, with its UK quarter choke steel shot equivalent patterns.

***Picture 7. True Cylinder choke (no muzzle constriction at all) is more than enough for Skeet, as even this tends to deliver closer to quarter choke patterns with steel shot. Skeet chokes can throw closer to a 1/3, or in some cases, even half choke patterns with steel pellets.***

**Conclusion**

**Using excessive amounts of choke constriction with steel shot is counterproductive, as it has the effect of delivering inconsistencies, with erratic pattern spreads, much longer shot strings, variable points of impact of the pattern placement and widely varying pellet velocities.**

**There is also the possibility that with repeated use, some guns may suffer damage to either the muzzle or choke tube, from excessive side thrust pressures through overly tight chokes from the non-yielding steel shot pellets.**

**Within the short ranges where steel can break targets reliably, open chokes are usually all that are needed.**