BISMUTH SHO

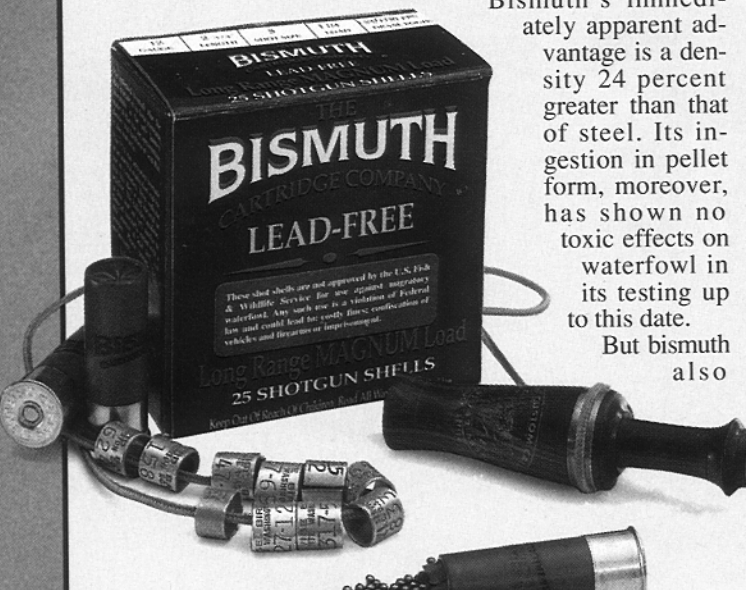
THE BALLISTIC POTENT

Do the physical properties of bismuth give it a decided ballistic advantage over steel as a material for non-toxic shotshell pellets? The purpose of this article is to show that the answer to this question is a clear "Yes."

Steel shot, which the U.S. Fish & Wildlife Service now makes compulsory for all waterfowl hunting, has caused much hunter unhappiness. The root difficulty arises from the low density of steel, only 70% that of the traditional shot made of lead, now banned for waterfowl hunting in this country.

Steel's lightness gives its pellets a significantly lower lethal effectiveness and a correspondingly higher capacity for crippling. It is this unfortunate situation that plainly identifies the pressing need for a better non-toxic shot material.

In direct response to this need, bismuth has emerged as the most promising alternative. Bismuth's immediately apparent advantage is a density 24 percent greater than that of steel. Its ingestion in pellet form, moreover, has shown no toxic effects on waterfowl in its testing up to this date.



But bismuth also has a further attraction. By contrast with steel's abrasive hardness, the metal bismuth is a much softer material that cannot mar the smooth surface of a shotgun bore.

Several recent articles have made very favorable assessments of this new shot's actual performance, though it must be made clear at the outset that bismuth shot is ***not legal*** for waterfowl hunting in the United States at this time.

One of the more thorough bismuth test evaluations appeared in Ross Seyfried's January 1993 *Petersen's Hunting* article titled "Sunset for Steel Shot?" For his tests against fixed targets Seyfried measured total penetration in wet phone books at 50 yds. with lead, bismuth and steel No. 5 pellets. His reported averages of 446, 404 and 300 broken pages, respectively, give a strong suggestion of bismuth's superiority over steel for energy delivery into a target.

Then, for his tests against moving targets, Seyfried took 300 rounds of baby-magnum 1⅜ oz. bismuth No. 5s and went waterfowl hunting in Argentina. His ammunition also included Winchester lead No. 6 and XX Magnum No. 4s.

To make a fair comparison, he mixed the bismuth and the Winchester factory loads and thus did not know what shells he had used until recovery of the empties. By Seyfried's account, he and his hunting companions were very successful with the bismuth loads. It was their collective experience, he tells us, that bismuth's lethal potency was indistinguishable from that of lead.

The successes in Argentina suggest very persuasively that bismuth will give us a much better non-toxic shot than steel. Yet, these results are not sufficiently specific to establish the actual superiority. A more adequate demonstration requires a direct comparison of downrange ballistic behavior, but for this we need to produce some numbers.

Our ballistic comparison will match the perfor-

Photo by Alan & Sandy Carey

mance of today's most widely used steel shot waterfowl load against that of an equivalent bismuth shot load. The arbitrarily chosen basis of comparison is the assessed lethal damage that each load can deliver to a fixed target, in this case a pattern-centered 5" circle at 40 yds. Although its actual size is not critical, the target's 20-square-inch area happens to approximate a mallard's vulnerable area.

The 1¼-oz. steel load, in a 12-ga. 2¾" shell, has a 3-ft. velocity of 1275 f.p.s. and produces 40-yd. patterns that can average up to 85% in a 30" circle. Because of steel's low density, 1¼ oz. is the maximum amount that today's cartridge engineers can cram into the 2¾" shell's limited volume and still produce a 1275 f.p.s. velocity.

Consequently, this 1¼-oz. duck load represents the outermost limit in the current state-of-the-art for 12-ga. 2¾" steel shotshell ammunition.

An equivalent bismuth load will need to have the same shot charge and 3-ft. velocity. It should also, like its steel shot counterpart, have the capability to average 85% patterns at 40 yds. Good patterning requires good pellet sphericity. In Seyfried's article we learn that his molded No. 2 size bismuth pellets, when loaded with buffering material, gave 40-yd. patterns that went as high as 92%. This clearly indicates that correctly formed and loaded bismuth shot can pattern just as well as steel.

There remains the selection of appropriate shot sizes. The most widely used size in today's waterfowl loads appears to be No. 2 steel. But, in the days when lead was legal, the preference was for No. 4. After steel became mandatory, the conventional wisdom held that a hunter should go up by two shot sizes. Thus, if No. 4s gave best results with lead, he should change to No. 2s when using steel.

If duck hunters find No. 2 the best size for steel and No. 4 the best for lead, then it follows that bismuth's shot size should be No. 3, as its density lies roughly halfway between

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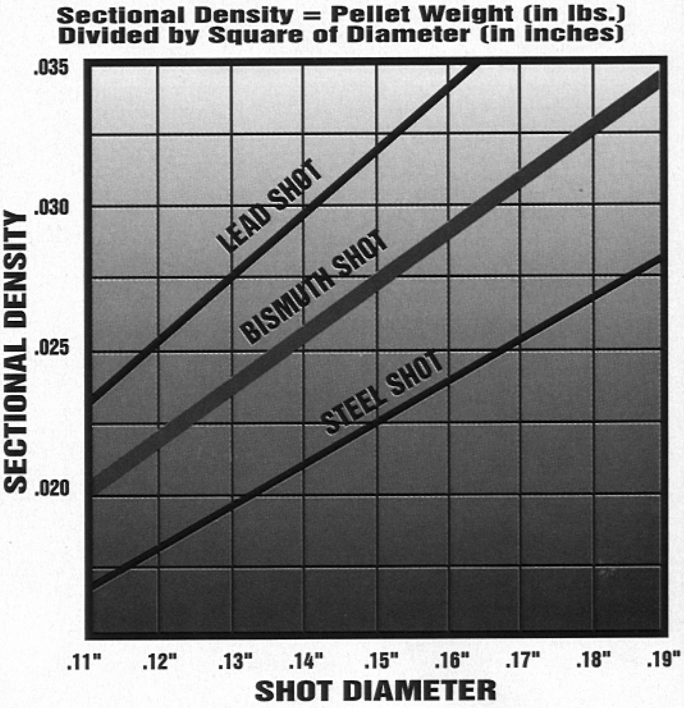
FIGURE 1
Sectional Densities of Spherical Pellets Formed from Lead, Bismuth or Steel



Placing cords with tape markers let NRA staffers record the effectiveness of bismuth loads against ducks in Mexico.

Bismuth was used successfully on ducks in a test hunt in Mexico by members of the *American Hunter* staff earlier this year. The shooters carefully documented the shooting distances.

Bismuth Shot

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the densities of steel and lead. The two contending loads are therefore going to carry No. 2 steel and No. 3 bismuth.

This performance comparison will proceed in two stages. The first one, based on what we know about the exterior ballistics and patterning behavior of shotshells, simply establishes the total amount of energy that each load delivers to the target at 40 yds.

In the second stage, the lethal effects of this delivered energy on a waterfowl target are assessed, based on what was learned from the experimental measurements in the two big duck mortality experiments at Patuxent and at Nilo (December 1992, p. 38).

Table I summarizes the results from the first stage. To provide a reference with the more familiar behavior of lead shot ammunition, **Table I** also includes the exterior ballistics of a 1¼-oz. load with No. 4 lead shot.

The key numbers are in the last three rows of **Table I**. They list, for each load, the average number of pellets hitting the target and the energy each delivers. Multiplication of the two numbers shows, in the last row, the amount of energy that hits our pattern-centered 5" circle.

The next step is to assess the lethal consequences of this striking energy. The way that impact energy converts into lethal damage depends very much on the physical nature of its target. With frangible clay birds, for example, where the only pertinent physical property is cohesive strength, breakage depends entirely on pellet striking energies. So if we just want to compare the relative effectiveness of steel and bismuth shot against inanimate clay birds, the numbers in **Table I** are all we need.

But against animate waterfowl targets, the situation is quite different. For one thing, measurements from the two big mortality experiments had disclosed that each striking pellet loses a portion of its energy penetrating feathers and skin. A pellet's remaining energy, that gets deposited in the target's vital regions, is its lethal energy.

Both mortality programs also disclosed that if two pellets deposited the same amount of lethal energy, the smaller one's energy is more lethally effective. Specifically, they showed that the pellet quantity that best correlates with lethal effectiveness (against mallards) is the pellet's lethal energy divided by its diameter squared. For convenience here, we will call this quantity "energy density."

Table II proceeds directly to an assessment of the lethal effectiveness of equivalent steel and bismuth loads. To make this comparison more specific, we put both the steel and bismuth loads into 12-ga. 2¾" shells and assume that our targets are mallards. Since a 2¾" hull can readily hold more bismuth shot, it can be argued that a fair comparison should match the steel load against one with 1⅜ instead of 1¼ oz. of bismuth. To avoid this argument, both shot charges are included.

TABLE I

Energy delivery to a 40-yd. target by 1¼-oz. duck loads with steel, bismuth and lead shot.*

	Steel	Bismuth	Lead
Relative density of shot alloy (gm/cc)	7.86	9.70	11.1
Shot size	No. 2	No. 3	No. 4
Pellet diameter (inches)	.15	.14	.13
Number of pellets in 1¼ oz. load	155	155	169
Average no. of hits on 40-yd. target	7.95	7.95	8.63
Energy per pellet at 40-yds. (ft.-lbs.)	3.55	3.94	4.13
Total energy delivered to the target (ft.-lbs.)	28.2	31.3	35.6

*The target is a pattern-centered 5" circle at 40 yds. All three loads have 3-ft. instrumental velocities of 1275 f.p.s. and produce 85% patterns at 40 yds. Each load uses the pellet size estimated to be the most effective against mallards. Abbreviations: gm/cc (grams per cubic centimeter.

TABLE II

Lethal effectiveness of 12-ga. 2¾" duck loads at 40 yds. with No. 2 steel and No. 3 bismuth shot. The target and the load ballistics are the same as in Table I.

	Steel 1¼ oz.	Bismuth 1¼ oz.	Bismuth 1⅜ oz.
No. of pellets in load	155	155	170
Pellet impact energy	3.55	3.94	3.94
Threshold energy*	.40	.40	.40
Pellet lethal energy*	3.15	3.54	3.54
Pellet diameter (ins.)	.15	.14	.14
Diameter squared	.0225	.0196	.0196
Pellet energy-density**	140	181	181
Avg. no. target hits	7.95	7.95	8.75
Total energy-density	1,113	1,439	1,584

*Threshold energy is energy lost in penetration of feathers and skin (see article); lethal energy is impact energy minus threshold energy.
**Energy-density is lethal energy divided by the pellet's diameter squared. As established by the Patuxent and Nilo measurements, energy-density is a pellet's lethal property.

Simple arithmetic steps produce the downward sequence of numbers in each of the three columns of **Table II**. The third row lists a threshold energy, the energy lost by each pellet in the penetration of feathers and skin. Measurements from both Patuxent and Nilo mortality programs gave it a value of .40 ft.-lbs.

Subtraction of this value from the 40-yd. pellet impact energy gives the pellet "lethal" energy, the energy actually delivered to the mallard's vulnerable regions. With steel shot, for example, this lethal energy is 3.55 - .40 = 3.15 ft.-lbs.

The next step takes the pellet diameter in inches, .15, squares it to get .0225 and then divides this number into the pellet's lethal energy, 3.15, to obtain 140, the energy-density value for each of the steel pellets. The next to last row shows 7.95 as the average number of pellets that strike the 5" circle area at the pattern center. Multiplication of this number of hits by 140, the energy-density calculated for each pellet, yields 1,113, the number that represents the steel load's comparative effectiveness.

The numbers in **Table II** may make a little more sense if we put them in the context of a real situation. Suppose the head of an ammunition company orders the development of a 12-ga. bismuth duck load. The only restrictions are that it be loaded in a 2¾" shell and not exceed industry's peak pressure standards.

A good cartridge engineer, with access to spherical bismuth shot and with a free hand to develop the best load possible within the restrictions, will produce a shotshell that is suitably described by the numbers in the last column of **Table II**. Against a pattern-centered 5" circle at 40 yds., this load's delivered energy-density totals 1,584 units. By comparison, as we can see in **Table II**, the best steel load in the same shell configuration can only deliver a total of 1,113 units. These are the two key numbers. They tell us that the bismuth load thus has a 42% greater lethal effectiveness.

Admittedly, the numbers in **Table II** are specific to a 5" circle and to a 40-yd. range. A change in the target's size will cause a change in the total striking energies, but the relative amounts will remain the same. If the range is extended, the percentage difference will increase very slightly because the denser bismuth pellets will lose a smaller proportion of their remaining energy. Accordingly, the estimated 42% advantage also applies reasonably well at other ranges.

Steel shot partisans are not going to like numbers that so clearly contradict what they have tried to make us believe. Their predictable opposition to bismuth will run along two paths. The first one denies steel's inferiority to bismuth on the ground that steel is as fully effective as lead. The second one alleges that bismuth pellets have some undesirable physical properties.

We need to examine both these contentions. To justify the doctrine that steel is equivalent to lead, the pro-steel lobby has created arguments which claim that:

1) a suitably chosen pellet size compensates for steel's lesser density and gives lead shot performance to a steel shot load.

2) some field tests have demonstrated the equivalence of steel and lead shot loads.

3) the Nilo program's evidence of steel's inferiority was obtained from unfair comparisons.

Since these same arguments will be wheeled out to dispute the ballistic superiority of bismuth, each has to be examined in turn.

The first argument—that a suitably chosen shot size "compensates" for steel's lesser density—asserts that steel No. 2s are equivalent in performance to lead No. 4s. Yet, in **Table I,** we see that No. 4 lead delivers 26% more impact energy than does No. 2 steel. Such a difference tells us that No. 2 steel shot does not behave like No. 4 lead. There is a reason for this, and it follows directly from a simple, elementary principle of exterior ballistics.

The principle is the following: "If two projectiles have identical shapes (e.g. both are spheres) but have different densities, then their exterior ballistic behavior will be the same if, and only if, their sectional densities are equal."

Figure I displays the sectional densities of spherical steel, bismuth and lead shot over a range of pellet sizes. It reveals that the sectional densities of No. 2 steel and No. 4 lead are not equal. A steel pellet has to be very much larger if it is to have the sectional density of a lead No. 4. For this it will need a diameter of .184", which translates into a size about halfway between BB and BBB.

TABLE III

Energy level of two 12-ga. 2¾" steel shot loads as total pellet energy at 3-ft. from muzzle.

	Original 1971 Nilo Load	Current 1¼ oz. Load
Shot Charge	1⅛ oz.	1¼
3-ft. Vel. (f.p.s.)	1332	1275
3-ft. Energy (ft.-lbs.)	1940	1975

And so the much-touted notion of No. 2s "compensating" for steel's low density, and thereby matching lead No. 4s, is rudely rejected by an elementary law of ballistic behavior.

(The U.S. Fish & Wildlife Service at this writing is accepting comment on its proposal to limit waterfowl maximum shot diameter to No. T (0.20") after a period of phaseout for the large No. F size (0.22"), which may place some constraints on the size debate. The Eds.)

The second pro-steel argument cites results of field tests, such as Schell-Osage, Tulelake, Shiwassee, Lacassine, etc. A big difficulty in these tests was the unavoidable loss of essential pellet impact data from the many unretrieved targets. A bigger difficulty was that different tests produced different conclusions and, in some cases, produced conclusions that were not supported by adequately documented data.

Yet the argument claims that these field tests demonstrated the equivalence of lead and steel shot. But does the collective evidence justify the claim? The answer to that question is "No."

The third argument attempts to discount the Nilo experiment referenced earlier. In this one big direct match-up between lead and steel, lead emerged the overwhelming winner. Efforts to explain away the Nilo results invariably fall back on a charge that Nilo used an underdeveloped, quickly produced steel shot load. Consequently, goes the allegation, it is unfair to judge the lethal effectiveness of steel shot on the basis of its behavior in the load used at Nilo.

This seems like a justifiable objection, that is until we look at the pertinent numbers. **Table III** gives the ballistic properties of two 12-ga. 2¾" loads with No. 4 steel shot. One is the current production load, which represents the best 1¼ oz. steel shot factory load that today's ballistic engineers have been able to put into the 2¾" hull. The other is the Nilo load, which the steel shot lobby has disparaged as "primitive."

According to **Table III**, the current factory load launches 1975 ft.-lbs. of pellet energy out the muzzle. Its advantage over the "primitive" Nilo load is a mere 35 ft.-lbs. The difference is less than 2%.

Such a trivial difference suggests that the state-of-the-art limits for steel shotshells were already reached at Nilo. Steel's density cannot be increased, its pellets cannot be made rounder and its scouring hardness cannot be much softened. This tells us that steel shot is now as good as it ever will be.

Thus, the doctrine that steel is ballistically equivalent to lead is emphatically contradicted by the laws of physics and by the measurements at Nilo. If steel pellets cannot be made to match the ballistic behavior of lead pellets, then there are no firm grounds for pushing the argument that steel can be made to match the ballistic behavior of bismuth.

With the failure of that argument, the case against bismuth turns to charges that its other physical properties make it an unsuitable material for shot. The basis for these charges rests on evidence that bismuth pellets have exhibited two objectionable characteristics, fracturing and poor pellet shape.

This evidence is real and points to a legitimate concern. John Taylor's "New Medicine For Ducks," in the May issue of *American Hunter*, reports his test with No. 5 bismuth shot and presents a good, clear view of the problem. Although Taylor's article reflects an optimistic partiality to bismuth, it makes no attempt to gloss over the difficulties.

His frank summary reports the recovery of many small shards from fractured pellets. It also records his observations on the worsening effects of misshapen and fractured shot on patterning and on penetration.

In addition to the broken pellets and

BISMUTH. Symbol: Bi. Atomic number: 83. Atomic weight: 209.00. Density: 9.8. Hardness: 2.5. Melting Point: 271° C. Boiling point: 1450° C.

Bismuth is a white metal having a reddish tinge, lustrous, brittle, not very hard, somewhat malleable, not very ductile. . . . The salts of bismuth are frequently used in medicine, principally in digestive disorders as a soothing protective to irritated mucous membranes.

(Van Nostrand's Scientific Encyclopedia, third edition.)

the patterns that did not go much above 70%, Taylor identifies a current manufacturing problem. The Bleimeister process is not yet producing acceptable bismuth shot larger than No. 5.

Yet, it we look again at Seyfried's article mentioned earlier, we get a much different and more promising outlook. At one point he says: "I fired some No. 2 shot that had been made in a mold. Each pellet was perfectly round, without some of the surface wrinkles found on my experimental batch of No. 5s. With these 'perfect' 2s all 105 pellets that went into the shells were recorded in the pattern. One round, with plastic buffer in the charge, stands as one of the best patterns I have ever fired. Ninety-seven of the 105 pellets were in a 30" circle at 40 yds."

Seyfried's and Taylor's articles may appear contradictory. They are not. Both sets of observations are consistent and are consequences of the unique physical properties of bismuth.

The attributes that have made this metal an attractive non-toxic shot candidate are its density, its relative softness and its lack of toxicity. The three physical characteristics that have led to the problems described by John Taylor are: its low surface tension in the molten state; its brittleness; its increase in volume during the change of state from molten to solid (i.e. like water, which expands upon freezing).

Surface tension is the physical property that is key to the formation of spherical lead shot in all but the larger sizes. In the traditional shot tower method, molten lead is continuously poured into a skillet-shaped cast iron pan with a large number of small holes. Repeated rapping on the pan shakes loose a rain of molten lead droplets. Surface tension then causes the exposed surface of each falling droplet to contract into the smallest possible area and thereby shapes the droplet into a sphere.

The fabrication process that depends on surface tension to shape free falling droplets of molten metal into spherical shotshell pellets can take place either in a shot tower or in a Bleimeister machine. From a shot tower the droplets fall about 150 ft. through air, while in a Bleimeister tank they fall just a few feet through heated water.

However, if the droplets are too large, this free fall process will not work. The size limit depends on the surface tension of the molten metal. With lead alloys, the limit corresponds roughly to a diameter of .18", or BB size. Bismuth has a much lower surface tension than lead and, as a result, a much smaller size limit. As already noted, the current limit for bismuth shot is about .12", or No. 5 size.

Accordingly, as has been the case with all lead shot larger than BB, the production of bismuth shotshell pellets larger than No. 5 requires an alternate method of fabrication. If the moldless free fall method does not work, then casting with a mold becomes an obvious alternative.

Seyfried's description of the "perfectly round" No. 2s made in a mold suggests it is also an alternative that solves the problem of misshapen shot.

Taylor, and others, have cited the problem of shattering with bismuth pellets. Shattering is the natural result of a sharp impact against a brittle material. And brittleness is a known property of bismuth. Consequently, when a column of unprotected bismuth pellets gets jolted by a powder charge and then gets suddenly and forcibly compressed during high speed movement through a choke, shattering can happen.

But shattering can also be controlled. A clue to this may be found, once again, in Seyfried's tests with molded No. 2s. For this test his loads contained a plastic buffer. All the pellets in one load reached the 40-yd. target, and more than 90% struck within a 30" circle. Since broken pellets will not do this, it appears that shattering was virtually eliminated in these buffered loads. Moreover, pellet protection by other means, such as plating, still remains to be explored.

Bismuth's increase in volume during the change from molten to solid state also presents a unique problem for free-fall formed shot. A falling pellet's outside layer cools and solidifies first. Then, when the inside cools and expands, it can break through the solid outer surfacce layer and cause pellet shape distortion.

This type of shape distortion has

Bismuth's Advocate

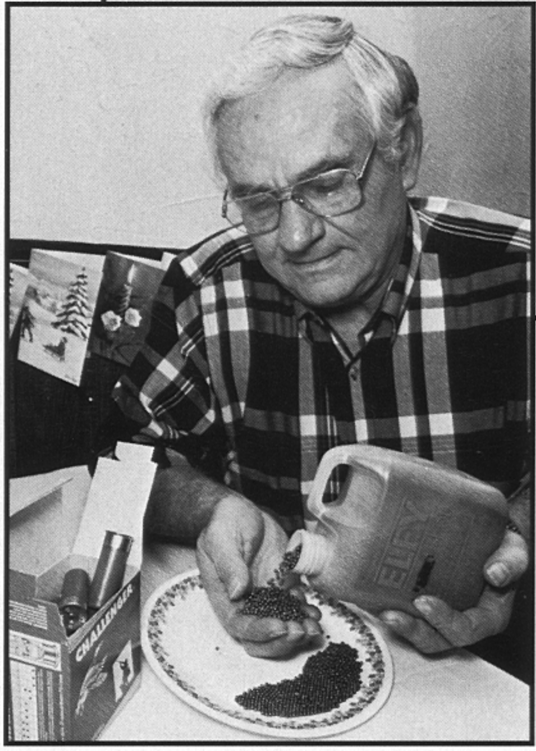
WATERFOWLING enthusiast John Brown, a carpenter in St. Catharine's, Ontario, was looking for a non-toxic alternative to steel shot when the idea of making bismuth pellets occurred to him back in the late 1980s. The idea wasn't exactly whimsical. Bismuth's relative density is approximately midway between that of lead and steel, and steel's lack of density (70% of lead) was recognized early on as its ballistic Achilles tendon.

Brown, who hand cast thousands of bismuth pellets by hand beginning in 1988 in proving his idea, ultimately secured a U.S. patent for bismuth shotgun pellets and has an international patent application pending. Significantly, that application covers the use of bismuth in rifle and pistol bullets. He also enlisted a very significant partner, magazine publishing magnate Robert E. Petersen, whose relevant publications include both *Petersen's Hunting* and *Guns & Ammo* .

Now, Brown has seen his idea licensed to Bismuth Cartridge Co. of Dallas, Texas, for distribution in North and South America, and the actual manufacture and distribution of bismuth loads is well underway. Canadian wildlife officials are considering permitting the use of bismuth shot in non-toxic shot waterfowling areas this fall, and Dr. Glen C. Sanderson of the Illinois Natural History Survey has completed a successful preliminary toxicity study on ducks.

Sanderson's follow-on comprehensive testing program, Brown says, will ultimately culminate in a submission to the U.S. Fish & Wildlife Service seeking legalization of bismuth shot for waterfowling in the United States.

Dr. Sanderson told Ducks Unlimited that meeting the government protocol would take three to five years and will cost $1.5 to $3 million.



While bismuth is receiving attention in the shooting press in both Europe and Australia, where it has been reviewed enthusiastically, Bismuth Cartridge Co., which has been using shot made by Eley-Hawk in England, is developing domestic sources for bismuth and attempting to resolve the manufacturing difficulties of making larger shot sizes, as discussed in Ed Lowry's accompanying feature.—RON KEYSOR been observed with dropped shot but, inasmuch as the dropped shot (i.e. free fall) process applies to small pellet sizes, its ballistic effects tend to be minimal. When pellets are misshapen they can reduce the patterning levels at full choke ranges. But the smaller sizes are generally used at the closer ranges where more open patterning is desirable and is controllable by the choice of an appropriate choke constriction.

Can this type of shape distortion occur with cast, larger-sized shot during the solidification of molten bismuth pellets? There have been no reported problems of shape distortion in the limited experiences with small samples of cast shot. Production quantities, however, must adapt to certain peculiarities of bismuth's unique metallurgy.

Victor Oltrogge, a top metallurgist, points to two pertinent properties of bismuth. The first one is its high latent heat of fusion, which is the amount of heat that must be given up in order for the molten metal to solidify. The second one is its very low thermal conductivity, or the rate this heat can be dissipated.

More specifically, Oltrogge notes that twice the amount of heat must be removed from an equal mass of bismuth (compared to an equal mass of lead) to freeze it, and the poorer conductivity further increases the total time to solidify into spherical form. Hence the necessary time for shot to remain in a mold may act to set limits on that mold's fabrication rate.

In summary, we need to remember that bismuth shot is at an early stage of its evolution. Its problems have been largely identified and have engaged the interested attention of creative metallurgists, ballistic engineers and mold-forming specialists. Their concerted, practical objective now is to exploit the full potential of bismuth metal for making shotshell pellets.

When that happens hunters will finally have a substantially superior alternative to the current mix of widely unpopular and ballistically inferior steel shot loads. ■

About The Author

Ed Lowry was employed by Winchester-Western Division of Olin Corp. in positions from research ballistician to research director from 1945 to 1973. He is the author of *Interior Ballistics* and *Exterior Ballistics of Small Arms Projectiles*, and numerous articles on shotshell performance in these pages over the years, the most recent, "A Closer Look With Steel Shot," in December 1992.

Picking A Hideout Holster

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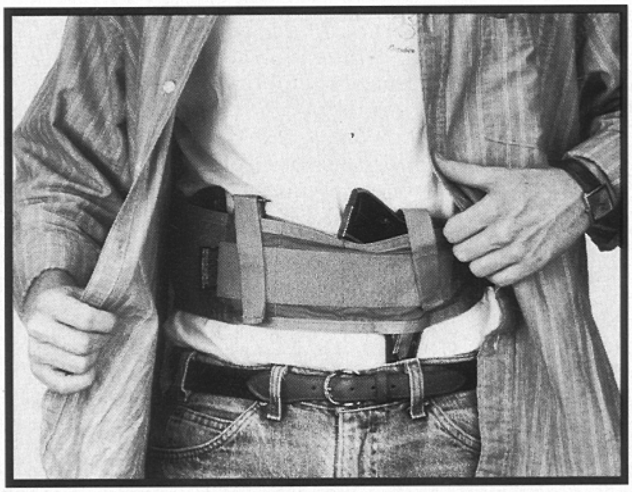
body. Some are large enough to accommodate a 6" barrel revolver or even a Government Model.

These packs have a regular pocket, closed with a zipper, for carrying handcuffs or spare ammo that disguises the real purpose. The gun is usually held in an elastic band and covered by the pouch, which just looks like a regular fanny pack. It's held closed by Velcro fasteners, and the gun can easily be exposed by simply pulling a strap or the corner of the pack.



Despite having to pull out a shirttail, Bianchi's Ranger Bellyband offers maximum concealment for smaller handguns.

One of the real advantages of fanny-pack-type holsters is that they can be used with any type of clothing, since the gun is concealed within something that doesn't look like a holster. But don't think it's a foolproof disguise. Anyone who is familiar with them can spot one a mile away. A recent variation from Michaels of Oregon looks like a small camera case and is worn on the belt. Variations on this theme such as one offered by Bagmaster Mfg. Inc., 2731 Sutton Ave., St. Louis, MO 63143, telephone (800) 950-8181, can either be worn on the belt or carried in the hand.

Finally, there are the bellyband holsters such as the Ranger Bellyband from Bianchi. There aren't too many of these, and they are worn like a money belt under the clothing. Again, only small guns may be carried this way, and their usefulness is limited by the fact that one must pull out a shirttail to get at the gun. They are good for concealing a backup gun for law enforcement officers or when the situation does not allow something more accessible.

Anyone who carries a gun should also carry at least one extra magazine or speedloader and, once more, the pocket may not be the best place. Spare pistol magazines are easily carried on the belt, and they are available in the same styles holsters are—inside or outside the pants; clip on or paddle; with or without belt loops.

Automatic pistol magazines are relatively delicate, and a damaged magazine can turn a useful pistol into a club. Carrying them loose in a pocket exposes them needlessly to dirt and lint and the possibility of damage. Also, if you need to reload, you need to be able to get to the magazine without having to sort it out from the rest of the stuff in your pocket.

The best way I know of to carry speedloaders on the belt is the "Split-Six" carrier from Safariland that covers the speedloader and goes behind the belt. The cartridges ride on either side of the belt and the Six-Pack simply covers them. For those who don't like speed-loaders, spare ammo can be carried in a pouch on the belt or in Bianchi's Speed Strips.

As far as I'm concerned, the best holsters for everyday use reside on the belt, either inside or outside the pants. An inside-the-pants style can be easily concealed with nothing more than a shirttail over it, but a conventional belt holster requires a jacket for best concealment.

Holster practice is just as important as pistol practice. A specific type of draw may be required to free the gun from a retention device, and ankle or shoulder holsters may require specific body movements.

Shoulder holsters can have an annoying tendency to pull the gun away from your hand as you reach for it. As the strong side shoulder moves forward to reach for the gun, the straps and normal body movement cause the gun to be pulled backward away from the hand. A cure is to rotate both shoulders forward as you reach for the gun.

The most important factor in choosing a concealed-carry holster is to find something that is comfortable. An uncomfortable holster tends to be left at home and defeats the purpose. The decision should be based on one's lifestyle, mode of dress, assessment of need and the type of handgun to be carried.

Over the years I've tried them all and have settled on the conventional belt pancake or paddle style as most comfortable for me, but just as it is with guns, there is no *best* holster. ■