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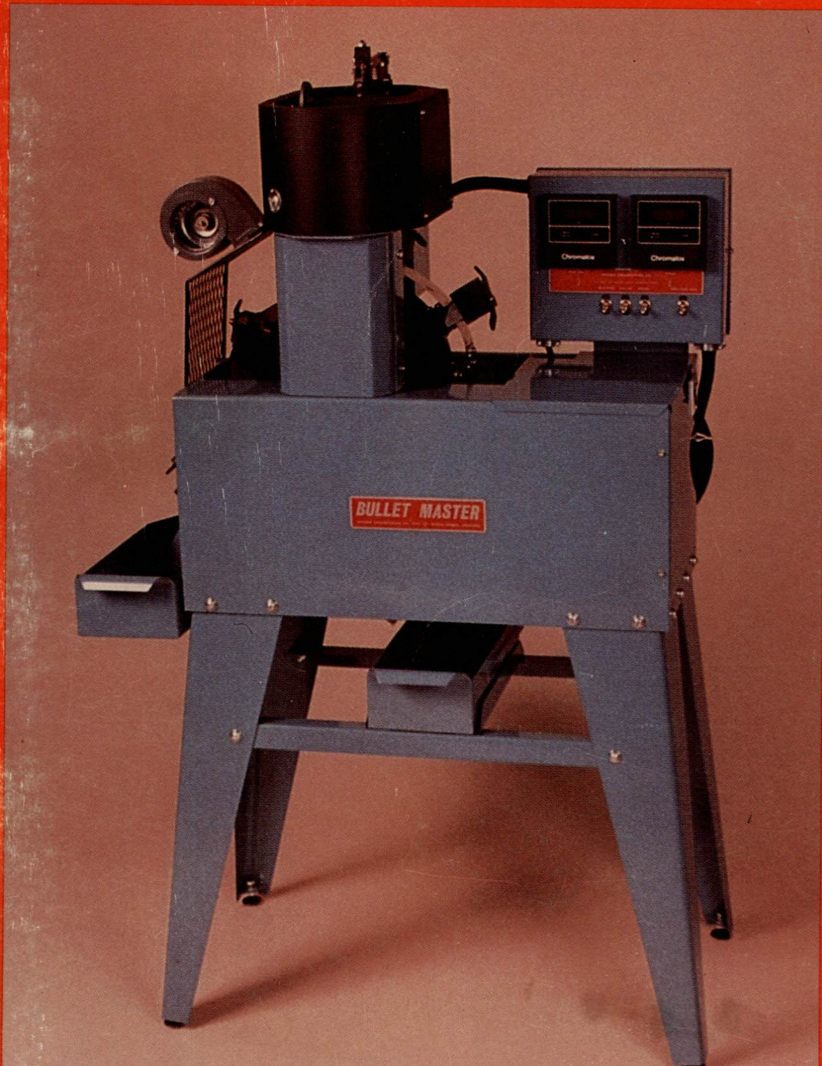
# THE HANDBOOK OF COMMERCIAL BULLET CASTING

## Second Edition

## Paul B. Moore



# The Handbook of Commercial Bullet Casting

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## *The Handbook of Commercial Bullet Casting*

The author would like to thank Bob Clausen, the owner of Magma Engineering Company, without whose help this handbook would not have been possible; also Dr Byron C Moore, without whose encouragement I would not have started this book, much less completed it; and Dr Ken Howell, my friend and editor, whose superb grasp of English prose style has made this book readable. Thank you all.

Chapters 2 and 10 were originally published by the author in *Handloader* magazine.

Chapter 4 was originally published by the author in *Gun Week* magazine.

# *Foreword*

DON'T LET THE TITLE of this little book fool you, fellows. This is indeed *the* handbook for commercial bullet casters, but the make-'em-for-money people aren't the only ones who need to keep it handy and consult it often. Any basement or garage bullet caster could tear out and throw away its chapters on the excellent machinery that Magma Engineering Company makes, plus its chapters on doing business as a commercial producer of cast bullets, and he would still have a manual on bullet casting that's worth more than it costs.

Every bullet caster alive needs to note that an awful lot of ancient folklore persists about the metals and means of casting bullets and that nearly all of it is most accurately described in crude and uncouth pasture terminology that isn't suited to the high quality of this little book. Just let me say boldly and plainly that **this book is *the word* on bullet casting**. If you know anything at all about casting bullets but you didn't learn it from this little book, then you know a lot that just ain't so. And you need to get it straight. This book is how you get it straight.

The two fellows who are mainly responsible for this handbook — Paul Moore (author) and Bob Clausen (publisher) — have been pals of mine for a long time, but this is my first opportunity to work with both of them at once. I can't think of any two men who might be better qualified to write and publish a handbook like this one — in fact, I don't know anyone else who has all the straight skinny on lead-based alloys, bullet molds and casting, casting bullets commercially, or making the machinery that a high-volume bullet caster needs.

First, by pure chance, I worked (in a manner of speaking) with Paul Moore some time before I knew there was such a fellow. His boss at the time — a honcho at the country's biggest producer of lead shot for shotshell manufacturers and handloaders, and core wires for manufacturers of jacketed bullets — called me to ask what kind of product I thought he might add to his company's line — presumably something for shotgunners and shotshell handloaders.

I suggested something else to him instead. Good alloys for casting bullets were then virtually a thing of the far-gone past, and this fellow's company had something close to a monopoly on both the smarts and the means for giving us at least one good cast-bullet metal. So I urged him to make and market at least one good, dependable alloy for casting bullets (preferably two). Another fellow had called me a couple of years earlier about producing alloys for bullet casters, but that lead merchant had ignored some of my sage counsel and had instead tried to market too many varieties — a separate alloy for every conceivable kind of cast bullet — and as a result, his business had flopped.

I suggested to Paul's boss that his company bring out just two bullet metals to cover all needs: a hard alloy that would make good rifle bullets, used straight, and pure lead so any bullet caster could "water down" the hard alloy to get whatever hardness he wanted in his bullet metal. Fortunately, the fellow then went to Paul Moore — his man for doping out lead-shot specs and seeing to it that the shot tower made the shot the way he designed it — and Paul came up with an ingenious chemical design for a "magnum" alloy that would cast easily and cleanly into good hard bullets and could be made with a minimum of the costlier tin and a maximum of the more economical lead. That was no small accomplishment.

Later, Paul sent me an article manuscript on using scrap alloys for casting bullets, which I edited and published in one of the magazines I was editor of at the time. That magazine article is still good enough to be one of the chapters in this handbook.

This fellow knows his stuff. In addition to having been the technical expert behind Lawrence Brand shot and Taracorp's Magnum bullet alloy, Paul is also the originator of a technique that for all these years someone else has been getting the credit for: heat-treating cast bullets (which he discusses somewhere or other in this handbook). That other fellow deserves credit for making the process known by writing about it, through the Cast Bullet Association, for example, but Paul is the bird who came up with it in the first place.

He obviously knows the ins and outs of lead chemistry and the lead-alloy industry, after his years of designing alloys for shot, solders, babbitts, and such. Since he spent those years also buying scrap from and selling alloys to that industry, Paul is well known and deeply respected throughout that industry. So you can take this to the bank: what he tells you in this handbook is not flimsy folklore or thin stuff from a hobby caster; it includes some of the meaty secrets of the lead-alloy industry, from one of its top professionals.

Paul is a metals chemist who specializes in lead-based alloys. He's also a shooter, a handloader, a bullet caster, an experimenter, and who knows what else — also inventive, creative, imaginative, ingenious, and versatile enough to be just the bird to turn out a handbook like this one — especially after a time of association with Bob Clausen, who designs the high-volume casting equipment that his Magma Engineering Company manufactures.

You can also depend on Bob Clausen and on anything he produces at his Magma Engineering Company. Bob is no wheeler-dealer, corporate raider, or financier from Wall Street — just a down-to-earth, old-fashioned, hard-working honest man who has no business being so successful in this dog-eat-dog world.

But *down-to-earth* doesn't mean lacking in class, and it does mean dependability. For Bob — and therefore for Magma Engineering, which is mainly Bob, his wife, and his sons — "good enough" never is. So one major Magma standard for design, production, and service is close attention to every major detail. And minor details are major details, too, at Magma. I know I sound like a paid mouthpiece for Magma, but I can't help it — in fact, I like it best when the truth about a friend sounds like flattery. In telling you what you ought to know about the fellows who put out this handbook, it just happens that I have to say some good things about Magma and its bunch of doodads for bullet casters. If you've tried 'em, you know. If you haven't tried 'em, try 'em — you'll see what I mean.

The author and publisher of this well stuffed little book, the company, and the machinery and materials produced there — are all class acts. I have the utmost confidence in everything these fellows send out with the Magma Engineering name on it, from a tube of lube or this handbook to the biggest and most awesome Magma bullet-making machine.

Ken Howell
Director, The International Cartridge Archives
Author, *Custom Cartridges*
Former Editor, *Handloader* and *Rifle*

# *Introduction*

IT IS ASTONISHING how many people are interested in casting bullets commercially but have absolutely no experience in casting bullets, either commercially or privately. Through this handbook's fourteen chapters, I hope to give interested first-timers not only a fundamental understanding of the business of casting bullets but also a clear explanation of the elements of casting good bullets. After all, it is not enough just to sell the bullets you cast — for commercial success, it's necessary to sell consistently good bullets.

At the other end of the spectrum are the fellows who have been casting bullets for themselves and perhaps for their friends for years. They have at least the technical expertise, yet they have little or no idea how to go about finding customers or making commercial contracts, or how to analyze their production costs or price their products effectively. This handbook also covers all these things — and more — in detail.

Another area that requires more than cursory examination is the subject of alloys and where you can find enough reasonably priced material to supply a commercial enterprise. The individual caster may easily purchase enough metal for his own use, but what happens if you suddenly face a contract to supply the police department with a ton of bullets a week? How are you going to be sure that each batch of bullets weighs the same and is composed of the same proportions of the same elements? Are all your bullets of the same hardness from lot to lot, from week to week?

How do the major metal refiners determine how much you have to pay them for your bullet alloy? How do you know whether they are quoting you a fair price? Do they want to charge you too much? How do you know? Are there any price standards — and if so, what are they? What happens if you get scrap metal that's not fit for casting good bullets? Can you make it usable? How? How can you convert it to the alloy that is best suited for the bullets you are manufacturing?

Cast bullets are for shooting, not just for selling. What is the best alloy for shooting that is also the most economical alloy for the bullets you want to sell? How can you equip yourself gradually for the business of casting bullets, to reduce the potential of losing much of what you have invested? How much money do you need, to get started? Finally, how can you work your way through all these puzzles safely?

We've written and published this handbook to give you answers to all the above questions, whether you're a newcomer to the business or already casting bullets commercially. Each chapter is a subject unto itself, and although it would be better to read them in order, you can read them in any order that appeals to you. The information collected into these fourteen compact chapters gives both the first-timer and the veteran caster the knowledge and references to prevent a great many problems that can occur in this relatively simple but potentially lucrative business.

We wish you both commercial success and personal satisfaction in casting bullets.

*The novice commercial bullet caster should find a source of commercially cast alloys for making bullets.*

1

# *The Economics of Commercial Bullet Casting*

WHEN YOU GET right down to the basics, the primary reason for most reloaders' interest in casting bullets commercially is the desire to make a little money at it — preferably, to make a lot of money at it. As in any business that markets a product, the fundamentals are relatively simple, but the details can sometimes be deceiving. For example, the fundamentals of the bullet-casting business are to buy your components at as low a cost as you can, manufacture your products as economically as you can, then sell your products for the highest price you can get for them.

You hope of course that your selling price substantially exceeds the sum of all your costs. But is this all there is to it? Of course it isn't. For example, suppose in an effort to keep manufacturing costs down, a manufacturer produces bullets that consistently demonstrate poor accuracy and lead barrels so badly that his customers refuse to purchase any more of his products.

That manufacturer immediately begins to lose sales. Eventually, he goes out of business altogether, because his product has a reputation so poor that negative word-of-mouth advertising alone has destroyed his business. Making second-rate bullets has cost him more than it would have cost him to make first-rate bullets. It is false economy to save a little money on manufacturing and lose a lot on sales.

It's much better to spend a little more on manufacturing so you can produce a superior product and get a better price and maintain a high volume of sales. Makes sense, doesn't it? But it is surprising just how many commercial bullet casters feel it is much better to produce a cheap product than it is to make a good one. That kind of thinking always causes you severe financial problems sooner or later.

Let's examine the fundamentals of selecting an alloy and how a good alloy affects productivity and bullet quality. The most frequently used material for cast bullets is undoubtedly the common wheel weight.

More than twenty years ago, a composite analysis of wheel weights would reveal an average antimony (hardener) content of approximately nine percent. That is no longer true. Today, there are two major compositions of wheel weights. The more common one contains about three percent antimony. The other contains about 0.75 percent antimony.

Besides its relatively low antimony content, the typical alloy used in wheel weights has no significant quantity of tin to improve the alloy's castability. Now if bullets were cast from lead alloy that contained only 0.75 percent antimony and no tin, the bullets would be soft and of poor quality, and the reject rate would be high. This would mean poor production. Of course, the wheel weights should not have cost nearly as much as say a commercially produced alloy.

However, the idea is not just to make bullets but to make *good* bullets.

If the wheel weights happen to be made from the three-percent alloy (most likely), then the hardness of the cast bullets is significantly better (although not good), and their castability is also improved (again, not good but better). These wheel weights should have cost the same as the other wheel weights, since only a laboratory can tell the difference between their alloys. On the street, "Wheel weights is wheel weights." Production is also better, and the reject rate is lower, improving productivity. The idea is to get the number of bullets manufactured per hour to the highest reasonable level while also maintaining quality up to a level that will make your customers continue to want to shoot your bullets. Sounds simple.

Because there are two alloys used in wheel weights, the reality of the situation is that any typical lot of scrap includes some of both compositions. This variety can cause problems. When two alloys are blended together, the final composition is some unknown proportion between the two known alloys. The proportions of the final alloy depend entirely upon how much of each scrap batch is in the lot. This means that it is relatively difficult to be consistent with the composition, because no two lots of scrap have exactly the same proportion of each alloy. This also means that not only the bullets' hardnesses but also their weights vary widely.

How can a bullet caster eliminate this inconsistency or at the very least control it? The easiest solution, but not always the most economical, is to purchase a specification alloy from a lead producer. The practicality of this solution depends on how much he charges for his product. Another way is to melt scrap in large quantities (a big batch) so that each lot is at least consistent, and variations in production occur less frequently. Another way is to learn how to blend your alloy yourself. That's a subject that we'll cover in another chapter.

If two bullets cast in the same mold (but from different lots of materials) do not weigh the same, the lighter bullet is normally harder and of better metallurgical quality. It also contains more antimony or tin (or both) than the heavier bullet. Antimony primarily adds hardness; tin primarily makes casting easier. Of course, antimony does add a little castability too, and tin also adds a little hardness.

There is also a point of diminishing returns. Antimony in concentrations much greater than about six percent usually increases the cost of an alloy much more than it improves the quality. And tin, in concentrations greater than about two percent, greatly increases the cost and only slightly improves the quality of an alloy used for casting bullets.

This is not to say that if you have an opportunity to purchase (for a good price) much material that is high in antimony or tin (or both) you shouldn't buy it. Get it. You can blend it down to an alloy that is more suitable, with lower-cost materials. In fact, the optimum composition for most pistol bullets is an alloy with approximately six percent antimony and two percent tin. At these concentrations, the alloy is about optimum for hardness *versus* cost and castability *versus* cost. With more antimony, cost rises rapidly, and hardness increases slowly. With more tin, castability rises slowly, and cost increases very fast.

## Clean Metal

One area that bullet casters often overlook when they use scrap material for bullet manufacturing is recovery. When an alloy melts, a waste material called dross forms on the surface and must be removed and discarded. Dross is nothing more than your metal combined with oxygen.

Unfortunately, unless you have a blast furnace, this material is waste and must be discarded or sold to a foundry that can smelt it (the preferred remedy). This dross is a factor that you must consider when you calculate what your bullets cost and how many bullets your material yields. For example, if you start with a hundred pounds of particularly dirty scrap metal that costs you twenty-five cents a pound, and you recover only seventy pounds of bullets and have to throw away thirty pounds of dross mixed with a little inseparable metal, the metal really costs you 100 divided by 70 times $0.25, or $0.3571 a pound. This is somewhat more than a quarter a pound.

Yield is particularly important in cost analysis and should always be considered when you evaluate the different sources of material. If you buy from a foundry — at thirty-five cents a pound — enough of the above material to cast the same number of bullets as your scrap that cost a quarter a pound, the bullets cast of the two materials cost essentially the same.

The foundry material does not have to be processed. You can use it as it is and save a lot of time. So the big question is this: if the foundry material costs fifty-five cents a pound, is it worth the extra time and energy to process the scrap yourself? Everything depends on momentary local conditions, and they change constantly.

Another element to consider is the relationship between your cost and your selling price. You buy your lead alloy by the pound, yet you probably sell your bullets by the hundred.

For example, you might want to sell 148-grain .38 wadcutters for $3.50 a hundred to be competitive. How much did the material for a hundred bullets cost you? Let's go back to our material that cost us twenty-five cents a pound at first. After it has been remelted and cleaned, it actually cost $0.3571 per pound.

Now we have a hundred 148-grain bullets. That 14,800 grains of bullets, divided by 7,000 grains to the pound, requires 2.11 pounds of material. At $0.3571 a pound, the material for those hundred 148-grain bullets costs $0.7550. If you figure your cost by simply multiplying twenty-five cents by 2.11 pounds, the result — $0.5275 per hundred bullets — is unrealistically low, not the true cost of the metal that you've used in making the hundred bullets. Use the net figure after casting to get a more accurate estimate of what your material actually cost. Your gross margin is now $3.50 minus $0.7550, or $2.745. Not bad.

Now suppose that you need to sell a hundred 250-grain .45 Colt bullets, also for $3.50 per hundred to remain competitive. These one hundred .45s weigh a total of 25,000 grains, which divided by 7,000 equals 3.5714 pounds. Multiply this by $0.3571 to get a cost of $1.2754 per hundred bullets. This is considerably more than the cost of a hundred of the .38 bullets. The gross margin is now $2.22 instead of $2.745 — more than $0.50 difference. This is typical bullet cost and pricing.

Heavier bullets typically earn less than lighter bullets. And naturally, they take about the same amount of time to manufacture — often a little longer. Of course, if competition allows, you can charge a higher price to account for the difference, to maintain the necessary margin between your cost and your selling price. Even at the cost of $1.28 for .45 bullets with a fixed selling price of $3.50, a margin of $2.22 is quite good. In fact, it is almost double what the bullets cost to produce. This is one of the reasons that casting bullets is an attractive venture.

## *Volume*

Naturally, if it takes you an hour to produce a hundred .45 bullets, the maximum hourly rate is a disappointing $2.22 per hour. This is about what you can expect from a single-cavity hand-casting mold and is considerably less than today's minimum wage. A hard day of hand casting with a double-cavity mold can produce about fifteen hundred bullets in about eight hours. This yields an hourly wage of $4.16 per hour and a day's earning of $33.28. This wage is not going to greatly increase anyone's bank account.

Volume is obviously a key to casting bullets profitably enough to make the business successful. Later chapters discuss slow, medium, and fast production equipment in detail to examine the advantages and disadvantages of each.

To examine the potential of the bullet-casting business, let's raise the production rate of .45 bullets, for example, to a thousand bullets per hour: the hourly wage at this rate would be $22.20. And if we assume that you'll sell all these bullets that you can produce, this would work out to annual sales of about $70,000 per year with a margin of about $44,400. This is not bad, either.

On the other hand, if you could increase your volume to 2,400 units per hour, and if you could sell all these bullets, the hourly return would be $53.28. Now we're talking! Your annual sales at this rate would be $168,000, and your annual margin would be about $106,560. This estimate is based on working only five eight-hour days a week. You can achieve this rate of sales with only one machine, and there is no limit to the number of machines that you can operate. This, in a nutshell, is why so many people are interested in the bullet-casting business.

The competition you can expect from others in this business deserves discussion. Who are the commercial bullet caster's competitors, and why should consumers purchase the bullet caster's products? The competition comes from two quarters; the big commercial manufacturers of jacketed bullets and other commercial bullet casters.

Why would anyone buy your products instead of the other fellows'? Let's take these questions one at a time. First, the commercial bullet manufacturers are primarily interested in selling jacketed bullets. Jacketed bullets cost about four times as much as cast bullets, and these companies don't sell cast bullets (they swage their lead bullets). In addition, the overhead and distribution costs of these companies are substantial and must be recovered in the selling prices of their products. They also must discount their products to accommodate distributors and dealers, and they have to consider freight costs. So it is quite easy for a "little guy" to compete with the big boys.

Why would a consumer prefer to buy your bullets? Let's face it — if he wants to shoot much, he'd better have a good bank account and learn to load his own ammunition. If he reloads, he can cut his shooting costs, sometimes by more than three hundred percent. Or he can shoot three hundred percent more ammunition for the same investment. If your bullets and your prices are better than he can get somewhere else, he'll prefer to buy and shoot your bullets.

How do you compete with other commercial bullet casters who are doing the same thing? You do that by being smarter and by learning as much about the business of casting bullets as you can. Then you can produce better cast bullets at lower costs than your competitors can. Your customers all want the best possible bullets for the best possible prices. Give them that combination — consistently and dependably — and you will be successful.

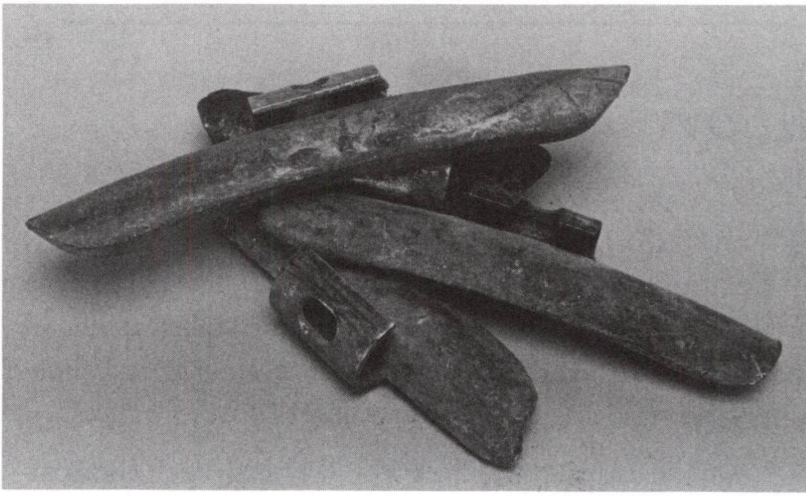
# 2

# *Alloys and Metals*

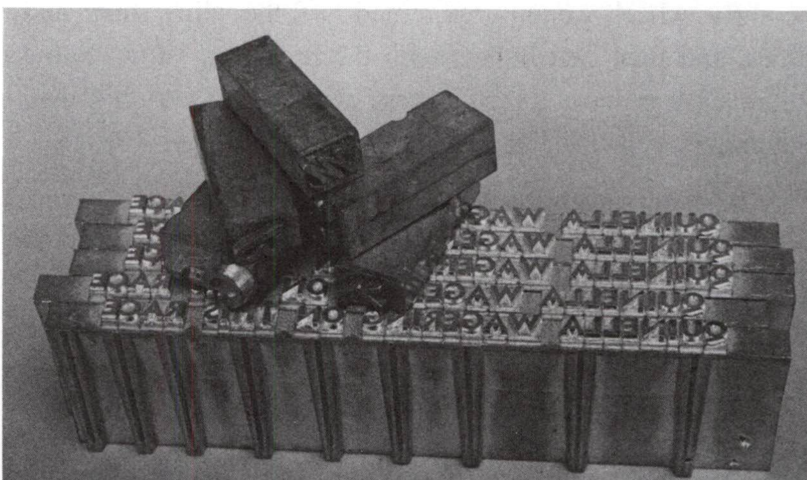
TO APPRECIATE how any lead-based alloy may affect the quality and the production costs of the bullets you produce, you as a bullet caster need a basic understanding of the kinds of materials you're likely to encounter and probably will consider using in the business of casting bullets.

Any discussion that involves the analytical compositions of scrap lead-based alloys definitely has to start with that most common source of salvaged lead alloys, the familiar wheel weight. There is probably not a bullet caster in the country who has not at one time or another melted a pot full of dirty wheel weights, skimmed off the clips, dirt, and dross, and then cast bullets with the remaining alloy. Some bullet casters have more success with wheel weights than others do.

It is not my purpose in this chapter to champion any one lead-based alloy over another as the one that's supposedly most useful as a bullet alloy, but to clear up the common misconceptions about the analytical compositions of the materials that are available to the bullet caster. All compositions listed in this chapter are extrapolated nominal chemistries determined by atomic absorption and classical wet analytical techniques. The performance of any given alloy in any single firearm is subject to a host of variables, and only one of these is the analytical composition of the bullet itself.



*There are two quite different kinds of wheel-weight alloy, and neither is what many bullet casters think wheel weights are made of ...*



*... and even more varieties of type metal, which make good bullets but are terribly hard to find.*

The only true test is to try it so you can see whether it works well for you and your system of casting.

Wheel weights have probably been used by bullet casters since very shortly after the first automobile wheel was balanced with them. Today, wheel weights are manufactured in two distinct compositions, which if mixed at random have a significant effect on the weight and hardness of bullets cast of them, undoubtedly contributing at times to the woes of the bullet caster who uses this popular scrap.

Analytically, the most common wheel weight is made of three-percent antimonial lead with the following nominal composition: antimony (represented in chemistry shorthand as *Sb*) 3.00 percent, tin (*Sn*) 0.29 percent, arsenic (*As*) 0.14 percent, copper (*Cu*) 0.05 percent, bismuth (*Bi*) 0.025 percent maximum, nickel (*Ni*) 0.002 percent maximum, zinc (*Zn*) 0.001 percent maximum, sulfur (*S*) 0.001 percent maximum, and the rest lead (*Pb*).

The residual elements of bismuth, silver, iron, nickel, zinc, and sulfur are essentially the same for almost all the compositions discussed — so we can ignore them unless they are present in significant amounts. To make matters even more difficult for bullet casters, a second reasonably common composition of wheel-weight alloy consists of antimony 0.68 percent, tin 0.017 percent, arsenic 0.08 percent, copper 0.05 percent, and the rest lead.

Unfortunately, there is no efficient way to separate these two alloys. And obviously, mixing these two quite different alloys in varieties of unknown proportions can have significant effects on the composition and thus the weight and hardness of bullets cast from the resulting mixtures.

*Table One — Analytical Compositions of Type Metals (%)*

| | Sb* | Sn* | As* | Cu* | Pb* |
|---|---|---|---|---|---|
| Electrotype | | | | | |
| general | 2.50 | 2.50 | 0.08 | 0.06 | 94.86 |
| general | 3.00 | 3.00 | 0.06 | 0.06 | 93.88 |
| curved plate | 3.00 | 4.00 | 0.10 | 0.08 | 92.82 |
| Stereotype | | | | | |
| flat plate | 14.00 | 6.00 | 0.06 | 0.06 | 79.88 |
| general | 13.00 | 6.50 | 0.07 | 0.06 | 80.37 |
| curved plate | 15.00 | 8.00 | 0.06 | 0.06 | 76.88 |
| Linotype | | | | | |
| standard | 11.00 | 3.00 | 0.08 | 0.08 | 85.84 |
| or | 11.00 | 5.00 | 0.06 | 0.06 | 83.55 |
| eutectic alloy | 12.00 | 4.00 | 0.08 | 0.08 | 83.84 |
| (Eutectic-alloy Linotype is by far the most common type metal.) | | | | | |
| Monotype | | | | | |
| ordinary | 15.00 | 7.00 | 0.08 | 0.06 | 77.86 |
| display | 17.00 | 8.00 | 0.07 | 0.06 | 74.87 |
| Lanston std | 19.00 | 9.00 | 0.06 | 0.06 | 71.88 |
| case | 24.00 | 12.00 | 0.06 | 0.06 | 63.88 |
| rules | 15.00 | 10.00 | 0.06 | 0.06 | 74.88 |
| Foundry Type | | | | | |
| hard | 25.00 | 13.00 | 0.06 | 1.50 | 60.44 |
| hard | 20.00 | 20.00 | 0.06 | 1.50 | 58.44 |
| hard | 25.00 | 12.00 | 0.06 | 2.00 | 60.94 |

* ***In this and other tables, Sb=antimony, Sn=tin, As=arsenic, Cu=copper, Pb=lead, Sr=strontium, and Al=aluminum.***

With the three-percent-antimony wheel weight containing more than four times as much hardener as the 0.68-percent-antimony wheel weight, the physical properties of the mixture change as the composition changes. The only effective way to handle the problem is to melt as large a batch as possible and cast it into ingots for later remelting into cast bullets. This would minimize small lots' variations in composition and at least produce bullets of consistent weight and hardness while the original batch lasts.

*Type metal* is a bullet casters' term that almost universally refers to Linotype or eutectic alloy. Unfortunately, *type metal* is really a broad name for no fewer than five categories of material used in the manufacture of type, and each category has three to five subclassifications. There are seventeen of these different type metals; Table One details the nominal analytical composition of each alloy. Fortunately for the bullet caster, Linotype or eutectic alloy is the most commonly available. That is, if you can find any Linotype metal at all, anywhere.

Note that foundry type contains a relatively large concentration of copper. As far as is known, no one has completed any extensive test of this material as a bullet metal, so its usefulness to the caster of bullets is unknown. In all probability, the copper would tend to come out of solution in the form of a high-melting intermetallic compound with tin and antimony, thus impairing the castability of the alloy.

Lead shot, although it is a single *class* of material, is in reality many different alloys constructed to impart different physical qualities to the pellets. Buckshot is normally soft or pure lead. Chilled or drop shot is normally a 0.50-percent antimonial lead (one half of one percent antimony). Hard shot, depending on its size and who made it, is two- to six-percent antimonial lead. Table Two lists specific analyses of shot types. Note in the analyses two elements that make these alloys unique. First, none contains tin. Second, both chilled and hard shot contain significant quantities of metallic arsenic. Arsenic metal is introduced into the alloy to reduce surface tension and thereby to improve the roundness of the pellets. Shot alloys contain no tin, which would negate the benefit of the arsenic.

*Table Two — Analytical Compositions of Lead Shot (%)*

| Shot | Sb | Sn | As | Cu | Pb |
|---|---|---|---|---|---|
| buck (all) | * | * | * | * | 99.96 |
| chilled (all) | 0.50 | * | 0.43 | 0.05 | 99.07 |
| hard BB, 2 | 2.00 | * | 0.50 | 0.05 | 97.45 |
| hard 4, 5 | 3.00 | * | 0.75 | 0.05 | 96.20 |
| hard 6, 9 | 4.00 | * | 1.00 | 0.05 | 94.95 |
| hard 7, 8 | 5.00 | * | 1.25 | 0.05 | 93.70 |

* *0.001 percent*

For the bullet caster, concentrations of arsenic greater than about 0.30 percent can create problems — not from the possible toxic effects, as you might expect, but because relatively large amounts of arsenic cause the metal to shrink unevenly and greatly increase the probability of cracked bullets, especially in the grease grooves.

There is a remote possibility that upon firing or loading a cracked bullet, a portion of bullet could remain in the barrel — creating a potential bore obstruction for the next shot

— or perhaps a piece of the bullet could break off and fall back into the case and cause potentially high pressures.

No one knows how probable it is that any of these undesirable things will occur. However, the potential results are severe enough that any lead shot that is to be used as bullet-casting material should be diluted enough to reduce the arsenic content to below 0.30 percent. *(Note: this figure is three tenths of one percent, not thirty percent.)*

Lead pipe is commonly thought of as being made of pure lead. Although this idea is not entirely correct, it isn't far from the truth. Most lead pipe is made from an alloy called chemical lead, which has a nominal composition of 0.05 percent copper and the rest lead. There is also a significant amount of antimonial lead pipe that contains anywhere from three to ten percent antimony, as Table Three shows.

*Table Three — Analytical Compositions of Lead Pipe (%)*

| | Sb | Sn | As | Cu | Pb |
|---|---|---|---|---|---|
| chemical | * | * | * | 0.05 | 99.92 |
| 3% pipe | 3.00 | 0.40 | 0.12 | 0.05 | 96.43 |
| 4% pipe | 4.00 | 0.25 | 0.15 | 0.05 | 95.55 |
| 5% pipe | 5.00 | 0.30 | 0.15 | 0.05 | 94.50 |
| 6% pipe | 6.00 | 0.40 | 0.25 | 0.05 | 93.30 |
| 8% pipe | 8.00 | 0.30 | 0.15 | 0.05 | 91.50 |
| 10% pipe | 10.00 | 0.30 | 0.10 | 0.05 | 89.55 |

* *Less than 0.001 percent*

The single peculiarity of lead pipe, other than its analytical variability, results from the fact that it is extruded, not cast. This peculiarity can deceive the bullet caster. When a lead alloy is extruded, it softens as it is worked into shape, sometimes substantially, giving the impression that the material is somewhat softer than it really is. This peculiarity should be of special interest to commercial casters and muzzle-loader shooters, since work-softened material that is remelted and cast into round balls is considerably harder than it was in its original extruded form. Always check the hardness of the bullet or ball itself, and never assume that the bullet is as soft as the raw material in its original form.

*Table Four — Analytical Compositions of Bearing or Babbitt Alloys (%)*

| | Sb | Sn | As | Cu | Pb |
|---|---|---|---|---|---|
| #1 | 4.50 | 90.62 | 0.08 | 4.50 | 0.30 |
| #2 | 7.50 | 88.62 | 0.08 | 3.50 | 0.30 |
| #3 | 8.30 | 83.02 | 0.08 | 8.30 | 0.30 |
| #4 | 12.00 | 75.00 | 0.10 | 3.00 | 9.90 |
| #5 | 15.00 | 65.00 | 0.10 | 2.00 | 17.90 |
| #6 | 15.00 | 20.00 | 0.15 | 1.50 | 63.35 |
| #7 | 15.00 | 10.00 | 0.15 | 0.08 | 74.77 |
| #8 | 15.00 | 5.00 | 0.15 | 0.08 | 79.77 |
| #9 | 10.00 | 5.00 | 0.15 | 0.08 | 84.77 |
| #10 | 15.00 | 2.00 | 0.15 | 0.08 | 82.77 |
| #11 | 15.00 | 0.25 | 0.20 | 0.08 | 84.47 |
| #12 | 10.00 | 0.25 | 0.20 | 0.08 | 89.47 |

Bearing or babbitt alloys are used primarily by the automotive and related industries for rod, cam, and crankshaft bearings. There are now hundreds of compositions of such bearings, but most of these are slight variations of twelve major categories (Table Four). Some of them would make fine bullet alloys, like #9, and others would be terrible — #3, for example. Unfortunately, there is no practical method of determining exactly which of these alloys a scrap supply consists of — only direct chemical analysis can determine this. But if you have found a babbitt alloy that makes good bullets, and they shoot well, there is no compelling reason not to use it for bullets.

Construction companies use sheet lead as a sound insulator for buildings. Bullet casters may find this material in and around buildings being demolished or at scrap yards. Table Five lists the four basic compositions of sheet lead. The vast majority of this material is manufactured from chemical lead, but significant amounts of it are produced from four-percent and six-percent antimonial lead. Sheet lead is not cast but rather rolled in rolling mills. Therefore, like lead pipe, the antimonial leads work-soften — and when you melt them and cast them into bullets, these bullets become harder than the material was in its original form.

*Table Five — Analytical Compositions of Sheet Lead*

| | Sb | Sn | As | Cu | Sr | Al | Pb |
|---|---|---|---|---|---|---|---|
| chemical | * | * | * | 0.05 | * | * | 99.945 |
| 4% sheet | 4.00 | * | 0.05 | 0.04 | * | * | 99.907 |
| 6% sheet | 6.25 | * | 0.10 | 0.04 | * | * | 93.607 |
| strontium | * | 0.90 | * | * | 0.15 | 0.02 | 98.927 |

* *Less than 0.001 percent*

Avoid strontium-lead sheet if you find any and know what it is (strontium isn't easy to detect.) This alloy contains aluminum, which increases the surface tension of the alloy and inhibits casting.

Ingot lead can normally be purchased through plumbing suppliers, and contrary to popular belief, it is usually not pure lead. Most lead distributed by plumbing suppliers has an antimony content of approximately 0.30 percent, with the rest lead. This material would make good base metal for alloying with other materials, but muzzle-loaders can not count on it being pure. If it causes no problem, then keep using it. But if there is a problem, the antimony in the alloy will be the cause of it.

Many houses today have lead-alloy roof flashings for vents. This material is composed of about 0.30 to 0.50 percent antimony, and the rest is lead. This material would also make a good base material for blending with other materials to yield harder bullet metal. Demolished houses are possible sources of this material.

Telephone companies use cable lead to insulate their underground wires from the elements. This material appears to be completely soft. However, since it is also an extruded product, it has the same properties of the lead pipe and rolled lead already discussed. It contains 0.50 percent antimony and is about forty percent harder than pure lead after it is cast into bullets. Scrap yards are the most likely source for cable lead, which makes a fine base for further alloying into bullet metal.

Note one thing about cable lead: the telephone companies coat the inside of the lead cable sheathing with grease and paper to make it weather-hardy. Scrap cable lead therefore smokes like the dickens and will smoke up your house or shop if you don't remove the grease and paper before you begin to melt the lead.

There are hundreds of types of cast solders. Table Six lists the nominal chemistries of the thirteen most common solders. Most of these can be purchased in one ingot size or another through local solder distributors or plumbing suppliers. Every bullet caster is familiar with fifty-fifty bar solder, yet not everyone knows that the first figure always refers to the tin content, and the second figure refers to the lead content of the solder alloy.

*Table Six — Analytical Compositions of Cast Solders*

| | Sb | Sn | As | Cu | Pb |
|---|---|---|---|---|---|
| 2/98 | 0.08 | 2.00 | 0.02 | 0.02 | 97.88 |
| 5/95 | 0.40 | 5.00 | 0.02 | 0.02 | 94.56 |
| 10/90 | 0.25 | 10.00 | 0.02 | 0.02 | 89.71 |
| 15/85 | 0.30 | 15.00 | 0.02 | 0.02 | 84.66 |
| 20/80 | 0.25 | 20.00 | 0.02 | 0.02 | 79.71 |
| 30/70 | 0.40 | 30.00 | 0.02 | 0.02 | 69.56 |
| 40/60 | 0.35 | 40.00 | 0.02 | 0.02 | 59.61 |
| 50/50 | 0.25 | 50.00 | 0.02 | 0.02 | 49.71 |
| 60/40 | 0.40 | 60.00 | 0.02 | 0.02 | 39.56 |
| 70/30 | 0.30 | 70.00 | 0.02 | 0.02 | 29.66 |
| 80/20 | 0.30 | 80.00 | 0.02 | 0.02 | 19.66 |
| 90/10 | 0.25 | 90.00 | 0.02 | 0.02 | 9.71 |
| 95/5 | 5.00 | 94.90 | 0.02 | 0.02 | 0.05 |

Of course, it seems that there must be an exception to every rule, and the solders are not exempt — notice in Table

Six that alloy 95/5 contains ninety-five percent tin and five percent antimony, with no significant lead content at all.

Hundreds of alloys are used in the manufacture of batteries. Unlike solders, battery lead is very poor for bullet metal. Of course, it is possible to salvage the terminals, but the plates are an entirely different matter. Manufacturers recover the lead in the plates through a smelting process in which temperatures reach from eighteen hundred to twenty-four hundred degrees Fahrenheit. To make matters even more interesting, battery manufacturers have begun in recent years to use calcium and strontium-lead alloys in manufacturing battery plates. It is possible, in attempting to melt calcium and strontium-lead battery plates, to liberate arsine or stibine gas — *which can kill you.* Avoid batteries as a source for bullet metal.

Deep alloying and refining is a subject that will be discussed in another chapter. However, a cursory treatment here is warranted. *Alloying* is a word used to refer to the mixing of two or more elements or materials to produce a third material that is in some way more desirable for some purpose than either of the original materials alone. For instance, if you mix equal portions of cable lead and Linotype, the resulting alloy contains approximately 6.25 percent antimony and 2.00 percent tin.

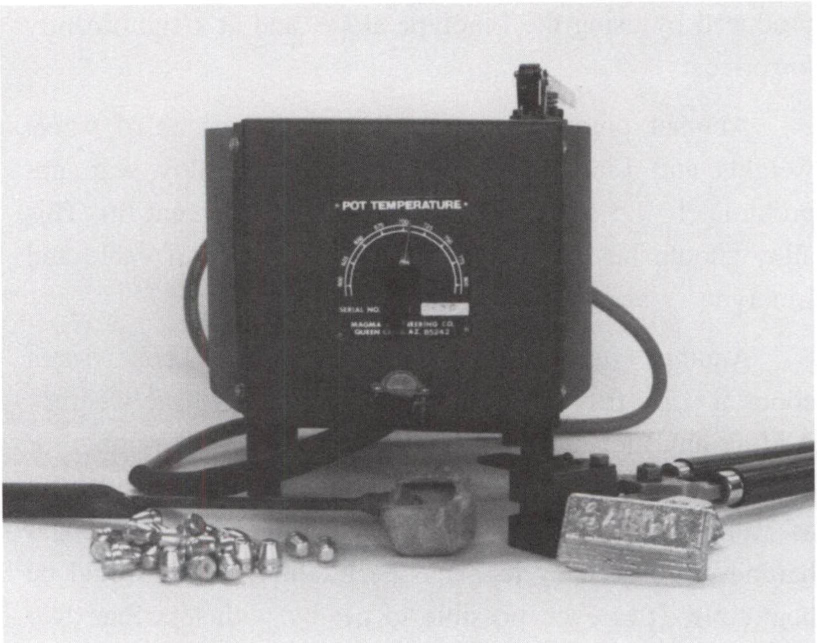
This is a useful alloy that does not waste the high tin and antimony content of the Linotype, yet it still has the hardness and castability needed for most uses. Another benefit is that the scrap cable lead is probably much less expensive than the Linotype, and alloying the two together doubles the number of quality cast bullets that could be produced by using the Linotype alone, and at a significantly lower cost.

Another possibility would be equal portions of wheel weights and Linotype, which produces an alloy with approximately 7.5 percent antimony and 2.14 percent tin. This alloy should be slightly harder than the alloy of cable and Linotype — and it is somewhat less expensive yet.

Another combination that has frequently been written about is fifty-fifty bar solder alloyed with wheel weights. Adding any more than two percent tin to wheel weights (or any other alloy used for casting bullets) would be wasteful as well as expensive. Also, the additional castability and hardness provided by higher concentrations of tin would be negligible. It is even possible to get by with less than two percent tin, depending on the bullet mold and style. Try it out, and see whether it works for you.

Whenever you melt, flux, and skim lead alloys, you refine them. Additionally, anytime you have anything undesirable in your alloy, regardless of its concentration, then that material needs to be refined.

For now, don't worry about the ins and outs of deep refining. Simply remember that the easiest and most efficient way to "remove" undesirable metals is to dilute the alloys that contain them, until the percentages of the undesirable metals are low enough to make their presence insignificant.




*Hand casting can produce excellent bullets — but not in the quantities necessary for a commercial enterprise.*

3

# *Casting by Hand*

ALMOST EVERYONE WHO plans to cast bullets commercially has already cast bullets by hand — by melting lead in a small pot and casting his own bullets, usually in single-cavity hand-held molds. This is a good way to begin, because it develops an intimate understanding of the intricacies of making cast bullets. It also makes anyone who attempts it understand that good bullet casting is also a matter of technique, not just equipment and supplies. *Technique* means that casting bullets is an ability that you must develop, not just a matter of doing something by rote.

The typical hand caster heats his metal over a gas or electric stove to an unknown temperature and casts until good bullets start falling out of the mold. At first, the bullets drop out of the mold quite shiny but all wrinkled and not well formed. The mold is too cold, or there is still oil residue in the bullet-forming cavity. After a few more casts, the bullets start looking pretty good — but the driving bands are still rounded off, and the metal is not quite so shiny. Then after ten to twenty casts, a perfect bullet falls from the mold. It is well filled out and has a nice silvery luster. Welcome to bullet casting!

The casting of lead into bullets (or balls) has been documented from at least the thirteenth century for use in hand cannons and the other muzzle-loaders in use then. Indeed, the use of cast-lead projectiles in slings goes back into antiquity. The Swedish infantry was using paper cartridges loaded with cast-lead projectiles before the year 1600. Presumably, a bullet mold was issued with each weapon and was specifically designed for that one muzzle-loader.

The spherical lead ball was used almost exclusively in war and in hunting from the fourteenth century until the middle of the nineteenth century. That's about five hundred years of casting round lead balls from molds. Right around the American Civil war, the use of conical bullets, or Minié balls, dramatically increased. They could not only be made more accurate, better for long-distance shooting, but they could also be made considerably heavier than the round balls then in use. This weight increase also meant considerably more striking force at greater ranges. This is very important in war as well as in hunting.

American firearm manufacturers also sold bullet molds with firearms. The molds of the day typically came with one, two, four, six, eight, or ten cavities and have been found made out of brass, iron, stone, and wood lined with clay, and with more than one size or type of cavity for casting more than one type of projectile at the same time. It is astonishing that in hand-casting lead bullets, so little has really changed in the last five hundred years.

## *Melting the Metal*

Almost everyone who casts bullets by hand starts by taking a bucketful of wheel weights and melting them down in a cast-iron pot on a gas or electric stove. Once the scrap lead is molten, the hand caster then skims off the junk (dross and iron clips) and fluxes his lead with a commercial flux (which may not be any good). In industrial casting, where this is done on a much larger scale, this fluxing procedure is called *dry drossing*. And believe it or not, instead of using a specially formulated flux, they use plain old ordinary sawdust. But they do one thing differently: they stir the dickens out of the lead to make sure the sawdust really mixes well with the lead. Once it is mixed well, the residue (dry dross) floats to the surface and is skimmed off, leaving the surface of the metal bright and shiny. This same procedure can be used no matter what the scale of melting, either individual or commercial. It is especially advisable for commercial use because of the very low cost of large quantities of sawdust as compared to the high cost of equivalent amounts of commercial fluxes.

This procedure begins when the lead is just molten — before it gets really hot. Dry drossing is done at relatively low temperature, not only because it minimizes flaming of the sawdust but also because the lower the temperature, the more copper is removed (if copper is present in excessive quantities as a "tramp" or undesirable element). It is like killing two birds with one stone. If dry drossing is done at a high temperature, and copper is found to cause casting problems, then the metal has to be remelted and then given a sulfur treatment to remove the copper from it. This is a waste of time and money when the copper could have been removed in the first place simply by keeping the temperature low enough.

Now, we hope, the metal is in condition to cast.

What is the proper casting temperature for your lead alloy? The answer is really quite simple. The best casting temperature for any given alloy is the *coolest* temperature that gives you the best bullets. Every alloy has its own "best" temperature, based on its constituents, and that casting temperature is affected by the temperature and relative humidity of the surrounding air and the accuracy of your temperature controls. So, in short, there is no one best casting temperature except the coolest temperature that makes good bullets *in that mold, from that particular alloy.*

And the only effective way to determine that temperature is trial and error, not only in hand casting but also in all the automated casting procedures in the upcoming chapters. This procedure not only allows casting in the safest possible manner but also extends mold life. Remember: the hotter the metal, the shorter the life of the mold.

Now that we are finally ready to begin casting, we discover that there are as many ways to pour metal from a ladle into a mold as there are people who cast bullets. This is called "technique," and every bullet caster develops the technique that works best for him. This technique can be divided into two fundamental procedures that can be altered to suit the individual.

The first procedure is to place the dipper spout into direct contact with the sprue mouth, invert the pair, pouring metal into the mold cavity, then remove the dipper and let a small amount of lead form a puddle on the sprue plate. The other procedure, the one I favor, is to hold the dipper about half an inch above the sprue hole and pour the lead directly into the mold — and pour a generous puddle on the top of the sprue plate.

This puddle or sprue is quite important, because as the lead begins to cool inside the mold cavity, it shrinks. If there is a generous amount of molten lead on the top of the sprue plate, the lead in the bullet cavity draws material into the cavity as it cools, allowing the bullet to be properly filled out. If there's no sprue, the bullet shrinks too much, and holes form in the base. These holes are called *shrinkage voids* and are generally caused by an inadequate sprue. Hold the mold steady as the lead cools.

If you examine the sprue carefully, you can tell from its mercuric appearance when the alloy first solidifies and turns from shiny to lustrous. Wait a few seconds — then with a wooden mallet, knock the sprue plate around on its hinge pin to cut the sprue from the base of the bullet. Drop the sprue into a pile separate from your bullets so that you can add them back into the pot between casts. A fairly steady procedure of dropping these sprues back into the pot helps maintain a constant casting temperature.

If you drop too many sprues into the pot at one time, your lead temperature falls too low. If you drop too few into the pot (*ie*, not often enough), the casting temperature slowly rises until your bullets start to look frosty. Although this frosty surface is not detrimental to the bullets, casting at too high a temperature — which causes the surface to "frost" — hastens the deterioration of your molds.

Open the mold blocks and lightly tap the junction of the mold handles with a wooden rod. The bullet should drop out. There are two things to remember here. First, the bullets are still quite hot and very soft. Drop them onto a soft folded towel or other piece of soft cloth so that dropping them doesn't damage them. Second, never strike your molds with anything harder or heavier than a wooden dowel or handle.

Striking them with any metal object can easily throw the mold blocks out of alignment and thus ruin the mold.

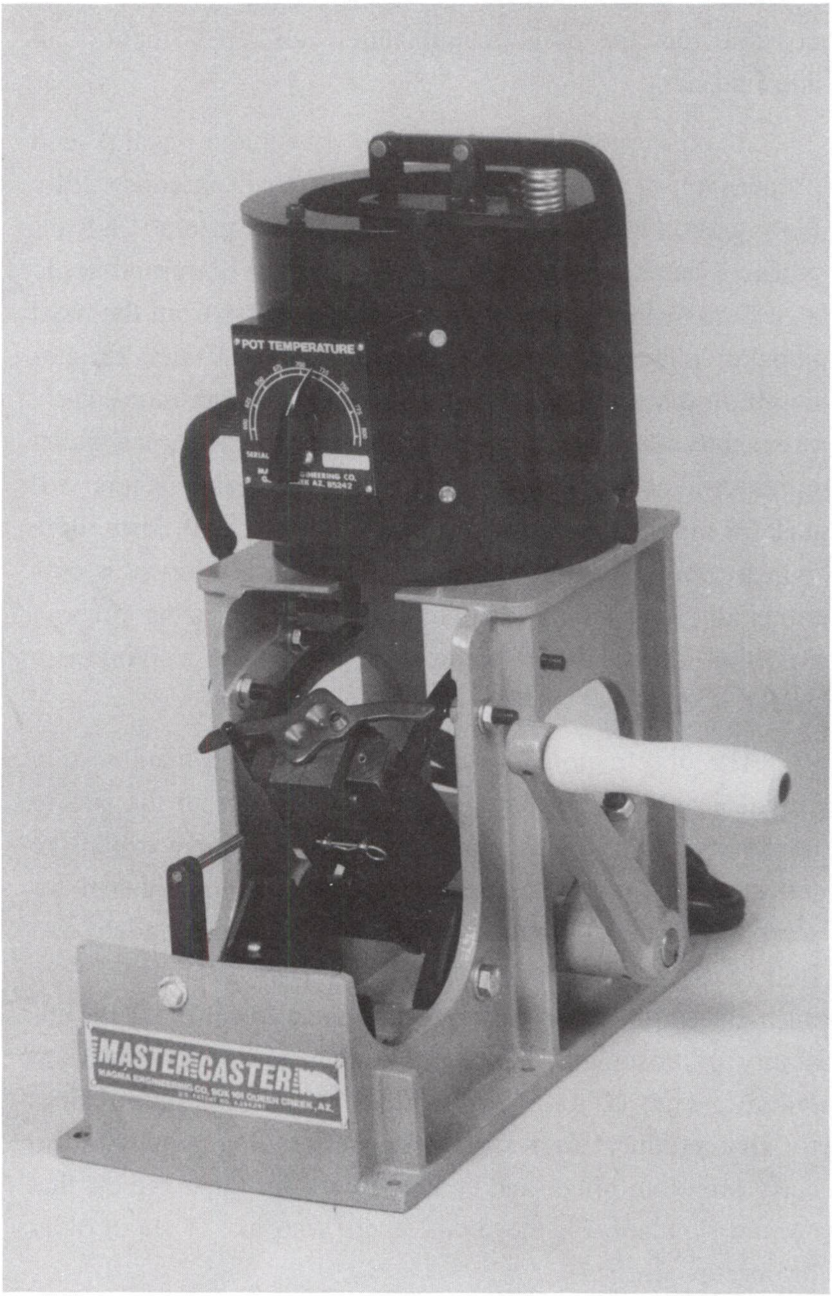
After your bullets cool, examine them very carefully and discard (return to the pot) any that are not satisfactory. Look for a bullet that is well filled out and has a good base. Remember, no bullet that has a malformed base shoots well. This means there must be no hole or inclusion in the base. Oddly enough, quite satisfactory accuracy is possible with bullets whose noses are radically deformed, but even slight deformation of the base ruins any hope of accuracy.

Also, carefully examine the surface of the bullet, looking for any black specks embedded in the metal. If you see any, discard (remelt) these bullets. These black specks are inclusions of foreign material and indicate that your metal has not been properly cleaned. Remelt all bullets that have inclusions and clean the metal in the pot again. Clean it twice if necessary.

Any bullets that have hair-like fins on them usually indicate that the casting temperature is too high. Reduce the temperature, and the lead tendrils should disappear. If the fins are heavy and blade-like, the mold blocks are not registering properly. Examine the mold faces to see whether a tiny obstruction is preventing the blocks from closing completely. If molten lead has formed on the face of a mold block, gently melt it off. Do not use a sharp instrument to scrape it off. Any damage to the mold face can severely alter the mold's ability to cast a good bullet. If there is no obstruction on the mold face, then the mold blocks probably need to be replaced because of chronic misalignment. It is possible that the mold manufacturer can repair them. Call and find out.

A consistent pouring motion (technique again) and proper care of the metal and the molds result in consistently high-quality hand-cast bullets. One of the primary advantages of hand casting is that more than a thousand mold styles are available to the hand caster, ranging from the most popular calibers to some quite different sizes. Bullets for ammunition that is no longer manufactured or is extraordinarily expensive are also readily available in the form of a bullet mold. And if that is not enough, several mold makers will make a mold to your specifications. Naturally, it costs more than a production mold, but it will allow you or your customer to shoot bullets that function properly in the firearm. And that is one of the secrets of how to make a living as a professional bullet caster.

The only major drawback associated with hand casting is that to produce volume, you must have one of the six- to ten-cavity molds — and they are not only fairly expensive but also very tiring to use. However, it is not unusual for someone to cast, lubricate, and size a thousand bullets cast from a two-cavity mold in one day. Hand-casting, from a business sense, is not really economical because of the inability of this method to make bullets in really significant volume. That is, unless you can command premium prices for that product. And as always, outstanding products also carry premium prices and could be used for those bullets that are not standard, for those customers who like to shoot older or obscure firearms.




*Magma's hand-operated Master Caster can produce seven hundred to eight hundred bullets in an hour.*

4

# *The Magma Master Caster*

AS THE YEARS come and go in the reloading arena, many ingenious devices come along that are supposed to make the life of the reloader easier, or more pleasant, or more accurate, or more something, or even all of the above. Many of these gizmos are no longer with us and with good reason. They just weren't worth their weight in bullet metal.

If most of these little doodads were made of lead, they would have long ago been cast into bullets and fired downrange — far downrange.

Occasionally, though, someone comes along with something that really makes a noticeable and worthwhile difference. Magma Engineering Company's Master Caster is truly one of those devices that fills a slot in the world of "very useful doodads."

Magma Engineering Company also manufactures a much larger, automatic bullet-casting machine called the Bullet Master Mark V. The Bullet Master Mark V is a machine of prodigious proportions and capability. It will dutifully, reliably, and with little observation crank out more than nineteen thousand bullets in one eight-hour day. That's a lot of bullets.

Even though I frequently shoot no small number of bullets myself, I would be hard-pressed to send nineteen thousand bullets downrange in one day and thereby keep up with the Bullet Master's impressively high production capacity.

The Bullet Master is obviously a machine that was designed with the professional bullet caster in mind. The Bullet Master is for a manufacturer — and until recently, your only choice was to use either multiple-cavity hand molds or a high-volume casting machine if you wanted to shoot a lot of bullets, or sell a moderate number, but in neither case more than nineteen thousand a day. So along comes Magma Engineering and creates one of those "why didn't I think of that?" machines.

The Master Caster is a fairly large-capacity 115-volt melting pot sitting on a heavy-duty cast-aluminum frame that holds a multiple-cavity mold under a bottom-pour orifice that is activated by thumb pressure when the armature is upright. It's easy. Your thumb dispenses a precisely measured pour of molten lead directly into a multiple-cavity mold. When you pull the handle down briskly, the mold automatically opens and drops the bullets into one box and at the same time drops the sprues handily into another box.

Using a two-cavity 148-grain .38 mold in the Master Caster, you can expect to produce between five hundred and eight hundred bullets per hour — a nice production rate. The actual rate varies, depending on casting temperature, alloy, and air temperature. Now that is the kind of production rate that makes sense to a high-volume shooter.

In addition, if you were selling bullets for $3.50 a hundred, that would be a daily sales figure of $224.00, a weekly sales figure of $1,120, a monthly sales potential of $4,480, and finally an annual sales potential of $53,760. Depending on your cost of metals, you can realize a hundred-percent return on your investment in as little as four days.

One of the specialty molds that I had a chance to look at was one for casting four-gauge maxi-balls on the Master Caster. This is one impressive projectile. Cast from an alloy of six percent antimony and two percent tin, the big "ball" weighed an impressive 2,188 grains. Now that is right between a third and a fourth of a pound of lead per bullet.

Although I think I am as brave as the next man, I have absolutely no desire whatsoever to touch off one of those antique monsters. I would be glad to watch someone else do it, though — just give me a minute to load my camera first. I would like hard evidence to prove that someone actually fired a four-gauge, that I really saw it in person, and that the shooter survived. Can you imagine shooting those loads from a bench?

Another interesting fact about the Master Caster is that the molds are not only manufactured from high-grade cast iron — they are also easily adaptable to the Bullet Master if the buyer decides to become a high-volume commercial caster. It is not unusual for these molds, with proper care, to cast more than a million bullets before they have to be replaced. Virtually all Magma's molds cast beveled-base bullets, which practically eliminate the shaving of lead from the sides of the cast bullets as they're seated in the mouths of the cases.

This feature, all by itself, significantly contributes to the accuracy of the Master Caster bullets I have tested. For those of you who are new to producing and loading cast bullets, it is typical for most bullet molds to be of the flat-base or the gas-check design. The case for any cast-bullet load should be belled and carefully chamfered to avoid shaving lead off the side and base of the cast bullet when it's seated. Flat-base bullets shave most easily, and gas-check bullets not quite as easily, but bevel-base bullets just slide right down into the case with little or no problem.

This is quite an advantage when you think of just how much time you spend creating, lubricating, sizing, and inspecting your cast bullets and consider the waste of a bunch of loads that are no good because you shaved the sides of the bullets when you seated them.

With any bottom-pour pot that pours the molten alloy directly into the mold cavities, it is very important to use clean alloy when you cast your bullets. In other words, if you are refining or cleaning scrap metal, do it in another pot. It is a very good idea to make up clean master alloys for casting bullets, to keep dross from building up in the orifice plate and thereby halting production until the quite hot orifice plate can be removed and cleaned. You can avoid all this fuss and mess by putting only clean ingots into the Master Caster in the first place. Incidentally, this is a good practice even if you are using a tin can and a dipper as your only bullet-making devices. A master alloy that you have properly cleaned and then cast into ingots extends the life of all your equipment — particularly your molds, which in time will become your most costly investment.

Protect that investment by cleaning your metal and casting it into ingots before you place it into your casting pot to form bullets. Your recovery of good *versus* reject bullets will be higher, too. Dirty metal plays havoc with the orifice plate on any casting machine, and the dirt rises to the surface of the bullet as it cools in the mold. Many times, this dirt is clearly visible with simple examination. These dirt particles, called inclusions, adversely affect the bullets' performance. When small inclusions are present, it is sometimes necessary to use a magnifying glass or low-power microscope to detect these inclusions. Yet if they're present, inclusions almost always degrade the bullet's performance and cause problems with the orifice plate.

Unfortunately, inclusions do not migrate to the surface evenly. Since they may at random concentrate on one side of the bullet or the other, depending on the cooling rate, they may leave the bullet out of balance around the longitudinal axis (the axis of rotation). In other words, the bullet spins out of balance and doesn't go where you want it to go.

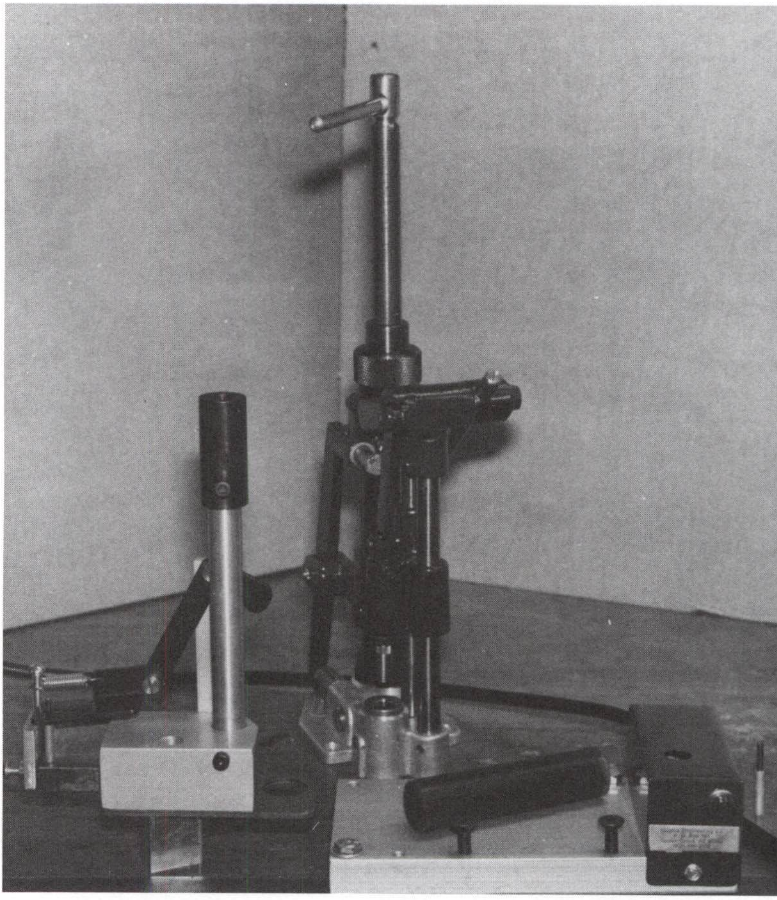
In dipper casting with an iron pot on a gas or electric stove, the most difficult thing to control is the casting temperature of the metal. Not so with the Master Caster. On the front of the casting pot is an electric temperature indicator that when checked against a thermometer at the factory was accurate to plus or minus seven degrees Fahrenheit.

As you may know, it is essential to hold the temperature of the metal to less than nine hundred degrees Fahrenheit. At that temperature, the lead alloy begins to give off fumes (colorless and odorless) that greatly increase the danger of lead poisoning. There is no need for the individual or commercial bullet caster ever to heat his bullet metal anywhere near nine hundred degrees — so don't do it. And what is the optimum casting temperature to use for any given alloy? Always use the coolest temperature that gives you the best bullets you can cast with your mold and alloy.

Testing many cast .44 bullets in my Dan Wesson led me to settle on that one caliber as a make-or-break test of the Master Caster. Using a SAECO dual-cavity mold that casts a 205-grain bullet 0.430 inch in diameter (with a six-percent antimony, two-percent tin alloy) as my standard, I loaded up a hundred 237-grain .44 bullets cast with the Master Caster. The nominal weight of the Magma bullet is 240 grains, but their actual average was 237.2 grains, plus or minus 0.15 grain. The standard deviation of 0.15 grain is very good for a machine-cast bullet (in fact, it is great for hand-cast bullets — means they're pretty consistent).

Hand-cast 205-grain SAECO bullets (each bullet hand-selected) loaded in front of 24.0 grains of IMR-4227 yielded a muzzle velocity of 1,422 feet per second in the eight-inch Dan Wesson and grouped 2⅜ inches at twenty-five yards. In comparison, the PMC 240-grain semiwadcutter factory load yielded 1,298 feet per second and grouped 2⅞ inches. Finally, the 237-grain Master Caster bullets yielded a muzzle velocity of 1,326 feet per second and grouped just slightly under 2¼ inches center to center — from an unsorted straight run of bullets that I cast immediately after the mold warmed up.

So if you're tired of standing in front of the stove hour after hour just to lay in a good supply of cast bullets, take a serious look at the Master Caster. Its production rate — five hundred to eight hundred high-quality cast bullets an hour — may be just what you're looking for. And if you choose to add high-speed machinery later, the Master Caster is ideal for casting relatively short runs of more or less odd sizes or styles while your big machines cast your high-volume stuff.



*The superb Star lubricator-sizer, fitted with Magma's high-speed accessories, can easily keep up with the moderate production volume of the Master Caster.*

5

# *The Turbocharged Star Lubricator-Sizer*

IF THERE'S ONE topic that veteran bullet casters profoundly disagree about, it is the sizing and lubricating of cast bullets. I hope, in this chapter, to shed a little light on these disagreements and at the very least give prospective commercial bullet casters a viable path of least resistance.

Bullet casters have long felt that all cast bullets have to be sized to fit precisely, or very nearly precisely, the bores of the guns they are going to be fired in. In other words, if the bore of a .44 Magnum barrel measures precisely 0.429 inch in diameter, then the cast bullet must measure 0.429 or 0.430 inch in diameter. And in truth, those appear to be the ideal cast-bullet measurements: right on or a thousandth of an inch larger.

The problem begins, however, when the bullet to be sized is somewhat larger than "right on or a thousandth of an inch larger." Sizing doesn't remove metal from any cast bullet. It moves the metal. It reshapes the bullet. It extrudes the bullet through a die. When you do these things to any lead bullet, two things happen. First, the lead is forced into other areas. If one of the areas is the base of the bullet, you will find that you lose accuracy just about as fast as you can push the bullet through the sizing die. The base of the bullet must remain flat, true, and square with the sides of the bullet to maintain any accuracy at all.

So if the bullets are quite a bit larger than the final diameter that they are going to be sized down to, the sizing operation is almost certain to degrade their accuracy enough to make them useless except for the most idle plinking.

The second thing that happens to the bullet, and one that most casters are not aware of, is that when any lead alloy is extruded, it work-softens. Let's repeat that. The alloy work-softens. It becomes softer than it was when it was cast. And by a lot, too. So after you have gone through the trouble to create a good hard bullet alloy, the sizing die has rendered everything that you worked so hard for almost a total waste of time. An alloy that has a hardness of Brinell 15, depending upon how much it has been sized, could end up with a hardness of less then Brinell 10 simply by being sized. So it would seem that to make the best bullets, sizing should be minimized.

But for the commercial bullet caster, omitting sizing can create some problems. First, for the bullet to be the most accurate possible, it should be exactly the groove diameter of the bore or only slightly larger. And second, it should not have been sized enough to reduce the hardness of the metal. Ideally, the bullets are not sized at all but simply passed through a sizing die that is the same diameter as the bullet, just to be lubricated.

This works well enough if the bullets are to be fired in only one gun whose bore is of the same dimensions as the as-cast bullets. Unfortunately, a commercial bullet caster has no control whatever over the gun in which his bullets are to be fired. The only solution is to size and lubricate the cast bullets to the individual caliber's nominal dimension or a thousandth of an inch larger. To cast bullets of the highest possible quality, the molds should cast bullets that are the same diameter as the sizing die to minimize deforming the bullet and work-softening the bullet's alloy.

To make matters even more interesting, all lead alloys shrink when they harden in the mold. Depending upon the antimony and tin content (as well as the casting temperature), each alloy shrinks a different amount. In addition, the mold manufacturers have to deal with individual tolerances in their machining of these molds, making the entire process almost impossible to predict before a trial run tells you exactly what diameter of bullets your mold casts.

Another area that causes novice bullet casters concern is the nominal weight of the bullet. Bullet-mold manufacturers must advertise their molds as casting a bullet of specific final weights. If they didn't give you at least a nominal figure, you would not have any idea what you were purchasing. However, every manufacturer uses a specific alloy to determine what his bullets weigh, and most of them use different alloys to make those determinations. At the very best, their alloys do not have the exact same composition as the one that you will be using.

This is a certainty. The result is that your bullets do not weigh what the manufacturer said they would weigh. At last, we have a bit of luck. This discrepancy makes absolutely no difference in the accuracy of your bullets, and you can use it to collect information about the bullet alloy you are using. If the bullet weighs less than the advertised weight, then your alloy contains more antimony or tin (or both) than the same bullet cast from the manufacturer's alloy. If the bullet weighs more than the manufacturer's advertised weight, then your alloy contains less antimony or tin than there is in the manufacturer's alloy.

In the first case, your bullets are probably harder than the manufacturer's test bullet, and in the second case softer than the manufacturer's bullet. Many individuals get upset over a difference in bullet weights *versus* the manufacturer's advertised weights. For example, if you are using molds manufactured by RCBS, you find that their molds are calibrated using three different materials. The first, Linotype, is used for calibrating rifle-bullet molds. The second, called one-ten alloy, contains one part of tin to ten parts of lead and is used for calibrating their pistol-bullet molds. The third metal, pure lead, is used for calibrating the RCBS line of round-ball molds.

So if you do not use the same alloys that RCBS uses, your bullet weights are not the same weights listed in the RCBS catalog. Occasionally, actual weights are not even close to the nominal or listed weights. Incidentally, from a cost standpoint, the one-ten alloy is very expensive and not nearly as effective as an alloy made from six percent antimony and two percent tin.

### Lubricants for Cast Bullets

There are about as many bullet lubricants on the market as there are bullet molds. Some work quite well, and some don't work at all. The difficulty lies in sorting out the ones that work well, under almost all conditions, from the lubes that don't work well. After having tried many different brands of bullet lubricant, I have found that the one that seems to work best under almost all conditions is Magma

Blue, produced by Magma Engineering Company in Queen Creek, Arizona.

After I've used this lubricant on Magma's 9mm 147-grain bullet — sized to 0.355 inch in diameter in Magma's modified Star Lubri-Sizer and shot into a dirt bank from forty yards — the bullets that I have recovered retained fifty percent of their lubricant — intact, in the lube grooves.

I fired some of these bullets from a Ruger P-85 at a ten-inch-diameter target, at a velocity of slightly less than a thousand feet per second, from a hundred ten yards away. Nine out of ten of these bullets struck the target, and the barrel showed no sign of leading after I had fired more than a hundred rounds. This is exceptional performance for any bullet from a P-85, let alone a cast bullet.

Many lubricator-sizers are available to the bullet caster. RCBS manufactures one they call the Lube-A-Matic 2. Lyman manufactures one they call the #450 Bullet Sizer/Lubricator, and Star manufactures the Star Lubri-Sizer. All these tools, used just as they come from the manufacturers, lubricate and size cast bullets well enough. Unfortunately, they are all slow, and if you expect to maintain any reasonable rate of production with them, you find that they certainly do not keep up with the Master Caster. They all can keep up with a simple hand-casting operation.

But there is hope for the commercial bullet caster whose volume is not yet up to a level that requires a Lube Master. Magma Engineering, the leader in commercial bullet-casting machines, also manufactures several add-ons that greatly increase the rate of production of the Star Lubri-

Sizer. Rates as high as a thousand bullets per hour have been reported. Not bad for a hand operation.

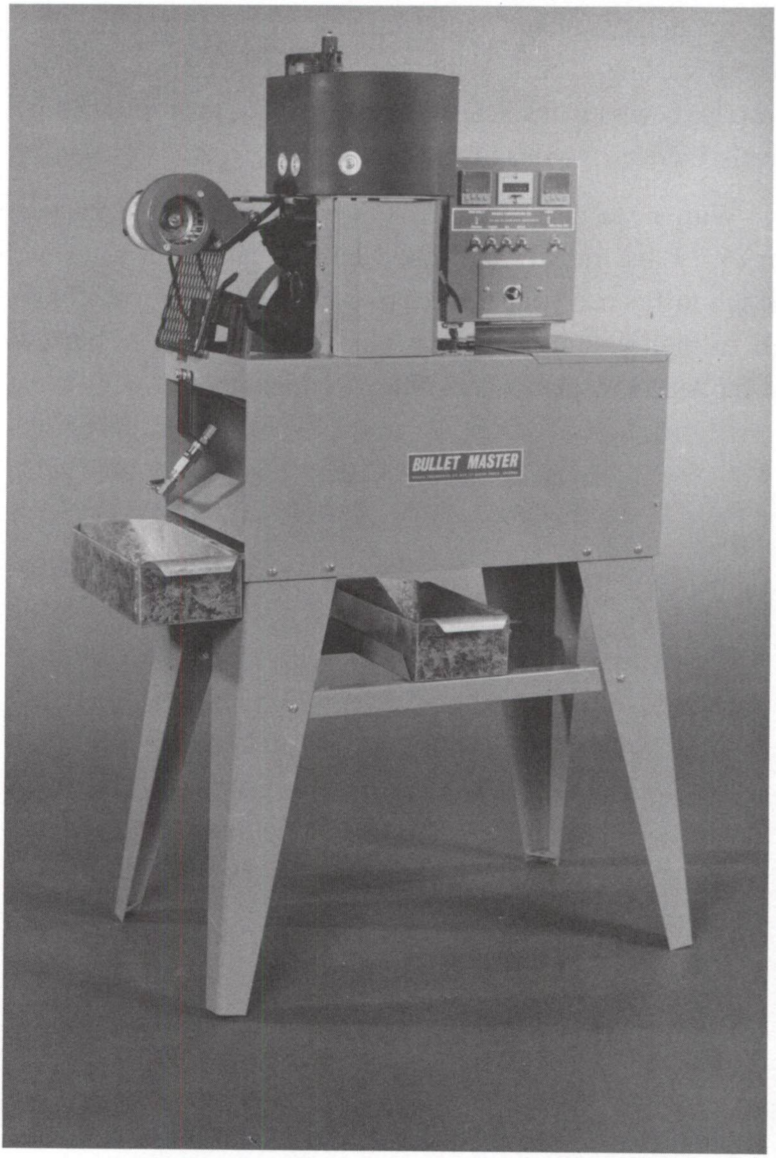
The accessories are a heater base (used for heating the Magma Blue bullet lubricant) and an automatic bullet feeder that greatly increases the rate at which the cast bullets can be fed into and removed from the Star. The Star sizer can be purchased complete, ready to go, for one group of calibers, and extra accessories are available to outfit it for other calibers. The accessories can also be purchased without the Star sizer if you already own one of these sizers.

Another important advantage of the turbocharged Star sizer is that it works quite well with the Master Caster as part of a balanced system. Also, like the Master Caster, it can be useful for limited production when it is not economically feasible to set up your major equipment for odd bullet sizes that command little sales volume but good prices.

For example, if you can lubricate a thousand bullets an hour and sell them at $3.50 a hundred, that translates into $35.00 per hour gross sales, or $280.00 per day. And if that is not a convincing argument, how about $56,000 per year, based on a work year of only two hundred working days? Now that isn't half bad for a completely hand-operated bullet-casting business.

Both the Master Caster and the turbocharged Star sizer work together as a team. With both of them in operation, you have a perfect transitional set of tools that allow you to easily make the transition from hand casting with hand-held molds to a successful moderate-volume commercial caster with a very modest initial investment. And you will have equipment that will continue to serve even if you move up from moderate-volume bullet casting to high-volume commercial casting. The last thing you want is for your equipment to become obsolete and to have to junk it, thereby greatly increasing your investment.

With a Master Caster and a turbocharged Star sizer, you can easily and rapidly cast good bullets until your sales are enough to finance your next step — upward — into the business of high-volume bullet casting without having to borrow the capital. Now that is something to think about.




*With eight molds in continuous operation, the Magma Bullet Master can cast more than 2,400 bullets an hour.*

## 6

# *The Magma Bullet Master*

SEVERAL MANUFACTURERS make automated bullet-casting machinery, but I'm going to discuss only one manufacturer's product here — because none of the other automated bullet-casting machines I have examined was high enough in quality to be of interest to a knowledgeable commercial bullet caster.

The high-quality machine, Magma Engineering Company's Bullet Master, has in improved versions been around for years. It is necessary that such a machine function well, and it is also necessary that replacement parts be readily available when and if a machine does break down. At least one other manufacturer states in his literature that once you buy your machine, spare parts are your problem. I believe their precise wording is "we are not in the spare parts business." I don't know about you, but I have never owned any machine of any kind that in time did not break down at least once. So when you look around for an automated bullet-casting machine, keep in mind that there is more to this business than just putting the machine together and running it forever.

Probably the most interesting trait of the Bullet Master is its high (which means money-making!) production rate. This machine can produce more than twenty-four hundred bullets an hour. This is 19,200 bullets per eight-hour day, ninety-six thousand bullets per five day week, and four million per fifty-week working year. Some commercial bullet casters run four of these bullet-casting machines simultaneously. This means they can turn out nineteen million, two hundred thousand bullets per year with weekends off and a two-week vacation every year.

Let's take a look at what this means in revenue at an average sales price of three dollars per hundred bullets. Nineteen thousand, two hundred bullets per day would gross $576.00. Ninety-six thousand bullets per week would gross $2,880, or about $11,500 per month, and 4,800,000 bullets per year would gross approximately $144,000. In addition, with four machines running, their total sales capacity would be more than $575,000 per year. That's not bad for a business that you can operate out of your garage, keeping overhead almost nonexistent.

And consider this: if you were to hire a helper, and the two of you run these four machines for sixteen hours a day instead of just eight hours, your total production potential would jump to just over $1,100,000 a year. Now there's an interesting possibility.

If you purchase a Bullet Master, read the instructions thoroughly before you try to put the machine together. This is so important, I'm going to say it again. *Read the instructions first.* These machines are really quite easy to assemble. In fact, Magma has completely assembled and tested them before partially disassembling them for shipment.

When the machine arrives, be prepared to unload the unit from a truck. The machine weighs several hundred pounds, so give some thought to who's going to handle it, and how, before it arrives where you are going to receive it from the carrier — and how you are going to move it to where you're going to set it up. Have a little help ready — human, mechanical, or both.

The machine requires 240-volt single-phase electrical current to operate. If you don't have this current, get an electrician to wire in the required current. You will also need a female receptacle. The Bullet Master does not come with a plug (everyone seems to have different outlets), so purchase a male plug to fit your receptacle. If you do not know how to attach the plug, *read the instructions* or have an electrician wire it up for you. It won't take him (or you, if you know what you are doing) more than a couple of minutes to attach the plug.

In the crate with the machine, you'll find its four legs and an H-shaped cross-member as well as a parts box. In the parts box are the bullet and sprue trays, fittings, and Allen wrenches. There is also a stick of lube for using on the machine. Assemble the machine. The assembly is obvious and should go very smoothly. With the machine facing you, note that on the left end, there is a solenoid. This is the sprue-tapping solenoid, and it has been mounted backward for shipping only. Remove the solenoid bracket, turn it around (180 degrees), and remount it.

If you look inside the melting pot, you will notice a trace of lead alloy solidified at the bottom. This is metal left over from the factory test of your machine. Before you turn the machine on, fill both sides of the melting pot with small pieces of bullet metal (reject bullets and sprues) to help speed up the initial melting process.

When this metal melts, add bullet alloy to the premelt side of the pot only. This precaution helps keep the metal that enters the molds clean and helps maintain a high quality of cast bullet. Now the Bullet Master is ready to run and should need no additional adjustment, since all its adjustments have already been set at the factory.

There are two Watlow digital-readout temperature controllers on the Bullet Master control center. The temperature settings also have been preset at the factory to approximately seven hundred degrees Fahrenheit. These settings allowed the machine to function perfectly at the factory, but you may have to adjust them when you try to operate the machine with your bullet metal, in your shop. The factory adjustment is based upon an alloy of six percent antimony and two percent tin at the normal air temperature at the factory. Depending on the air temperature and humidity in your shop, as well as the specific alloy you are using to make your bullets, you may have to adjust the temperature settings. Remember, the best casting temperature is the *coolest* temperature that produces good (well filled-out) bullets.

Under no circumstance let the metal temperature exceed nine hundred degrees Fahrenheit. Lead gives off fumes at nine hundred degrees, and these fumes greatly increase the danger of lead poisoning. I'll have more about this in the chapter on safety — but for now, just don't let the lead get hotter then nine hundred degrees. In fact, you will probably never have to exceed 775 degrees, regardless of your alloy.

In addition, remember that if you are casting in an unheated garage in the winter in Minnesota with an air temperature of fifteen degrees below zero, you will probably have to cast at a higher temperature just to keep your molds at the proper temperature. If you are casting in Death Valley with the air hot enough to dry-poach eggs, the opposite is the case. In any case, avoid drafts — they adversely affect the quality of your bullets. Remember, you are trying for consistent quality, and drafts affect each mold differently, creating inconsistent casting quality.

To begin casting, turn on the POT switch, then wait for the metal to melt and for the preset temperature to appear on the digital readout. The load light should be off. Then turn on the MOTOR switch. Turn on the remote switch. This switch is behind the machine, on the left. The casting wheel should now be rotating and indexing. Turn on the VALVE switch, and you should see metal dropping into the molds. You are now making bullets.

Bad ones.

The machine has to operate about twenty minutes before the mold temperature is high enough for the bullets to come out well formed. Put all sprues and bad castings back into the premelt side of the pot. Remember, keep your metal clean and skim it often enough so that dross does not build up on the surface of the pot.

If you are not getting good bullets after about twenty minutes, check to see whether the sprue cutters are properly aligned with the mold blocks. Stand at the right end of the machine and look closely at the sprue cutters. If they are not aligning properly, tap the resetting arm with a small hammer to the right or left side as required and continue casting.

If the sprue cutters do not need adjustment, watch the streams of lead to see whether they are falling directly into the holes without striking the sides of the sprue cone. If the lead streams are not dropping straight into the holes, you can adjust them laterally by loosening the melting pot and sliding it from side to side. If the longitudinal setting needs to be adjusted, look into the left end of the machine and note the clevis engagement with the pivotal arm. Remove the hairpin cotter and the clevis pin. Rotate the clevis clockwise to increase the distance the wheel travels, or turn it counterclockwise to decrease the distance. Reinstall the clevis pin and hairpin cotter. Remember, all these settings have already been set at the factory and should not need adjustment.

Don't turn on the cooling blower attached to the machine until the molds have reached their proper casting temperature, and then only when you are casting large bullets — and then only if they are not setting up fast enough. Smaller bullets don't need the cooling fan at all. The switch to turn on the blower is on the main control panel.

The adjusting screw mounted over the valve arm is for adjusting the lead flow through the orifice plate. Turning this screw either increases or decreases the pouring rate through the valve. Adjust the duration of the pour with the INCREASE knob on the drive motor. The duration of the pour is correct when the two sprues on the two-cavity mold blocks are joined and fall off in one piece when the sprue plate cuts them off.

If the sprue is too small, then it likely does not separate, causing a misfill on the next cycle. In addition, it is much easier for the machine to dislodge the sprue, and you get a better mold fill when the sprue forms properly on top of the sprue plate.

The lead in the pot is at the desired level when the lead is no lower than the height of the float-valve orifice. Always add lead to the premelt side of the pot, so that this level never drops below the float-valve orifice, to maintain an even pouring pressure on the valve side of the pot. Keep the lead level above the float-valve orifice to prevent impurities (drosses) from getting into the valve.

If the float valve gets plugged and continuously transfers lead into the valve side of the pot, wiggle the float-valve arm to clear it. If the head pressure on the valve becomes too great, the lead pours so rapidly that it splashes and spatters. This problem causes bullets to have hollow bases, an undesirable feature. If the head pressure is not great enough, the lead flows too slowly, causing wrinkled bullets to form — also an undesirable feature. In addition, overfilling the premelt side of the pot causes the float-arm swivel to jam. If this happens, disassemble the float arm (after it has cooled) and clean it thoroughly. Reassemble and continue casting.

On the underside of the pot is a disc with two small holes in it. This is the orifice plate. If the alloy you are using is not particularly clean, these holes can become plugged with dross. A couple of Allen-head screws hold the orifice plate in place. If you have to, you can remove the orifice plate while the pot is still hot and the metal is molten, but it's much safer to let the pot cool to room temperature before you remove the orifice plate. The valve is above the orifice plate — and if the valve leaks when you have removed the orifice plate, molten lead drips down onto your hand and into the machinery. This is also a result of using dirty metal.

Again, use only clean lead alloy if you want to extend the life of your operation and machinery. If you are going to use scrap lead, first clean, refine, and cast it in an auxiliary pot or furnace and cast it into small ingots for later use in your Bullet Master.

To clean the valve if it gets plugged or partially plugged with dross, cool the system to room temperature, remove the orifice plate, and heat the system back up again. Flush the valve with the orifice plate out of the pot by working the valve arm by hand to move lead through the valve. Insert a flat tray between the valve and the molds, to catch the lead pouring from the open bottom of the pot. Clean the valve base and the small channel while the pot is still warm.

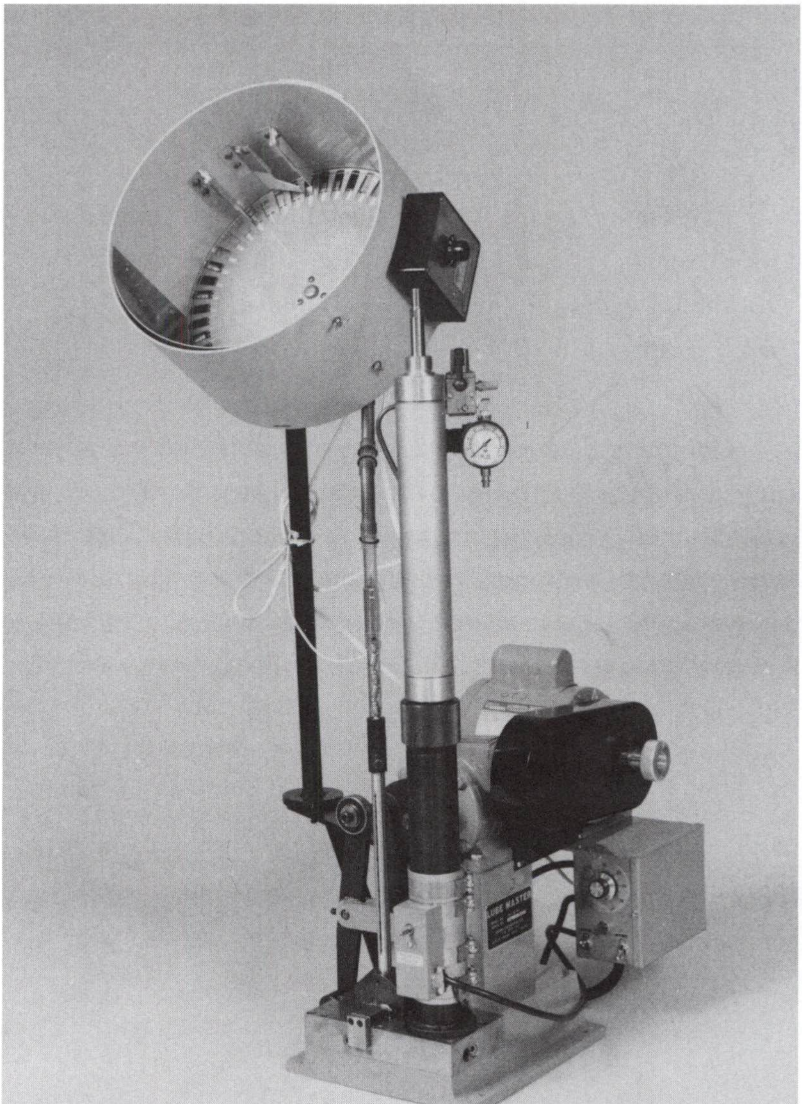
After the machine has cooled down again, install the orifice plate and resume operations.

To change the mold set, use the pin punch (provided in the accessory box) to drive out the two 3/16-inch roll pins on top of the carrier arm next to the mold. The pins will drop out, so be ready to catch them. After you drive out the two pins, grip the spring-loaded base of the mold carriers with the modified vise-grip pliers also provided in the accessory box. Adjust the pliers to hold the mold slightly open. With the pressure on the carrier arms eased, slide the mold out of the carrier arms. While they are still compressed, slide in the new replacement mold, and then drive in the roll pins. Do this with the other seven molds, and you have completely changed the set.

Flux your metal often to keep the surface bright and shiny. Use a piece of your bullet lube about the size of a garbanzo bean, but flux only the premelt side, not the valve side of your melt. You should have to flux only a couple of times a day if you started out with clean metal in the first place and you haven't melted dirty scrap directly in your Bullet Master.

Everything in the Bullet Master is self-lubricating except the cams and carriers. Lubricate both cams and carriers, with the lubricant provided, twice a day to minimize wear on these bearing surfaces. Do this after the machine has warmed up, for good lubricant flow.

Complete detailed instructions and drawings come with each machine, and there is no really good excuse for not reading them. Magma Engineering is regularly improving their machines with new engineering materials and methods, so instructions may change. These machines are high-quality, moderate-investment items. Treat them well, and they will last many years before they need any repair. All Magma's machines can be retrofitted to new-model status at the owner's option — another plus that you might want to keep in mind when you compare commercial bullet-casting machines from several manufacturers.




*The Magma Lube Master, fitted with an M-A Systems automatic bullet feeder, can lube and size more than 38,000 bullets in an eight-hour day, while you operate a Bullet Master to keep it fed with bullets.*

7

# The Magma Lube Master

IF YOU'VE READ the earlier chapters in this handbook, you know that the Magma Bullet Master machine, or a series of them, can produce extraordinary volumes of cast bullets. Now that you have cast them, how on earth are you going to lube and size all those bullets? In fact, how are you going to do it without interrupting your casting operation?

The Lube Master is the answer. When it's outfitted with an M-A Systems automatic bullet feeder, the Lube Master can lubricate and size more than thirty-eight thousand bullets in one eight-hour day. That is enough production to keep up with two Bullet Master machines. In addition, it takes only a couple of minutes (at the most) to load the feeder bay.

This means that you can leave the Bullet Master machine running, making bullets, while you charge the Lube Master with bullets to be lubricated and sized. There's no need to interrupt your casting, so one person alone can easily operate two Bullet Master machines and one Lube Master machine, to cast, lubricate, and size more than thirty-eight thousand ready-to-market bullets in one eight-hour day. If you're willing to hustle, you — alone — can run four Bullet Masters and two Lube Masters simultaneously to produce more than seventy-six thousand bullets a day.

Before you select a particular bullet-sizing die, remember that any bullet that is sized too much work-softens. This means that if you have selected a good hard alloy for your bullets, then you size them down too much, you destroy all the effort that you have put into the bullet so far. Select a bullet mold that delivers cast bullets no more than two thousandths of an inch larger in diameter than the sized bullets' final diameter. This is not quite as easy as it sounds.

All of Magma Engineering's molds are calibrated to deliver bullets at the advertised diameter using an alloy composed of six percent antimony, two percent tin, and the rest lead. If you use a Linotype alloy that contains twelve percent antimony and four percent tin, your bullets cast to a larger diameter — because the harder alloy shrinks less than a softer one.

Conversely, if you use scrap wheel weights for your bullet metal (three percent antimony, the rest lead) your bullets shrink more, and you cast bullets smaller in diameter. This shrinkage affects the amount of sizing that your bullet requires and can significantly alter the quality of your bullets. In addition, all bullets within a given caliber function well within a range of bullet alloys. This means that quite a few alloys work well, not only one. If your bullets are too large, try softening your alloy by adding pure lead to your mixture. If they are too small, try adding Linotype or fifty-fifty solder to your mix to decrease the shrinkage.

As always, there is a side effect to adjusting alloys. The first one is that if you add solder or Linotype to your alloy, you increase your cost. If you add soft lead to your alloy, you decrease your cost but also make your alloy somewhat softer. The second side effect is that if you use a very hard alloy, the bullets do not shrink as much, and you may have some difficulty with your bullets not dropping easily from the molds. If this happens, you can improve bullet release by installing the Magma pneumatic bullet knockers. A pleasant side effect of this installation is that it makes the Bullet Master operate considerably quieter.

If you purchase molds from SAECO, Lyman, or RCBS, you must order a complete set of eight, of course. Do not have Magma order the molds for you. Order them yourself, and check them by casting your alloy in them. You want do this for several very good reasons. When Magma Engineering manufactures molds, they produce them in sets — and the sets remain together. This is not so with the same number of molds from the other manufacturers. It often happens that another manufacturer's "set" of eight molds cast several different diameters, with adverse effects on the quality of your bullets. This sometimes happens, because you can easily receive molds from several different lots produced at different times, from different cavity-cutting cherries. Not only do the diameters of your bullets vary — their weights vary, too. If this happens, to the molds you order, keep the ones that meet your requirements and return the others to the manufacturer for exchange.

If you ship these molds to Magma Engineering to be adapted to the Bullet Master, Magma will adapt your molds to fit your machine, however they cast. Remember, they are your molds, and Magma Engineering assumes that you have purchased what you want. Magma will make certain that your molds operate well on the Bullet Master machine. However, they can not warranty the quality of the bullets produced from someone else's molds.

I'll have more for you on mold life and quality in the chapter on molds and mold care.

When you first uncrate your Lube Master machine, the first thing that's instantly obvious is the quality of materials and workmanship built into each machine. Each machine is hand-constructed and is designed to last a lifetime with proper care. Mount the machine on a firm surface. A heavy bench will do nicely.

The Lube Master pushes sized and lubed bullets out the bottom, so provide for this either by cutting a hole in the bench or by mounting the machine forward so that you can mount a tray beneath it to catch the finished bullets as they drop out of the Lube Master. In addition, you can store the sized and lubricated bullets temporarily in tubes — protected for later packaging — by screwing a suitable copper-tubing adapter to the fitting mounted below the sizing die.

As always, before you operate this or any other piece of equipment, **read the instructions thoroughly**. *After you've read the instructions*, install the vent plug in the top of the speed reducer, then bolt the lube tube to the base block.

The Lube Master uses standard Star sizing dies, and Magma Engineering recommends that you lube your bullets through the bottom set of holes only. Plug the unwanted holes with #7½ or #8 lead shot. The holes in the die are stepped, so the shot will not pass through the wall of the die. You can easily remove the shot later by drilling it out with a #44 drill if you wish.

You can remove the die for inspection or replacement by disconnecting the spring from the end of the transfer bar and sliding the bar out the front of the machine. The hole in the base block that contains the Star die has been machined to a press fit. To remove the die, use the rod provided with the machine and tap the die upward until it is free. While the transfer bar is out of the machine, insert the proper size of bushing in the bar for the bullet to be sized. Magma provides an Allen wrench that fits the set-screw that locks this bushing in place.

There are three tube and bushing sizes: #1 is for 9mm and .38 bullets; #2 is for .41 bullets; and #3 is for .44 and .45 bullets. A special transfer bar is available for .32 and .380 bullets. To adjust the bullet punch, loosen the lock nut and turn the punch in or out to the desired depth, using the flats on the punch to turn it. A quarter-inch end wrench is the correct tool to fit these flats properly.

Since the bullet location is critical to proper lubricating, you can check its location easily by removing the die with the bullet in place and marking it with a pin through the open lube holes. Adjust the punch to align the lube grooves on the bullet with the open holes in the die.

The Lube Master has a heating element in its base, paralleling the lube passage to the die. Because room temperatures and the melting points of the different kinds of bullet lubricant all vary, there is no specific recommended operating temperature. Start with a temperature setting of 100° Fahrenheit. If you want the machine to warm up somewhat faster, increase the set temperature to 120° F until the lube tube is warm enough for the lubricant to flow, then return it to the normal operating temperature.

To fill the lube tube, unscrew the knurled cap from the top of the tube and pull the plunger from the cylinder. You'll need to use a good bit of pull to get this plunger out, because of the strong suction created by the piston. Insert a new lube stick (maximum diameter two inches, maximum length seven inches; smaller sticks are all right, if you have them) and replace the plunger and cap. Never operate the Lube Master without bullets being fed into the system, because excessive pressure can build up on the lube pump and cause the pump to fail. In addition, never operate the Lube Master cold, as this will also damage the lube pump.

Do not overtighten the drive belt. The belt should not slip during normal operation but must be loose enough to slip a little in an emergency. The belt drive is a protection for the machine's parts: if a bullet hangs up in the system, and the punch impacts on the transfer bar, the belt has to be loose enough to slip — to prevent the machine parts from shattering. This is important for the longevity of the machine. *Do not overtighten this belt.*

To ensure the maximum useful lifetime of the Lube Master, lubricate all its moving parts with a good grade of light grease. Also, send a sized and lubricated bullet back into the system after every hundred bullets to keep the sizing die lubricated.

Finally, when you shut the machine down for the day, always be certain to have the pump arm bearing on the high point of the cam. Then, if you inadvertently start the machine the next morning when it is cold, the lube punch will not be rammed into the cold lube set in the lube-pump assembly, which could damage the machine and gear box.

If the lube pump eventually fails, remove it and replace it — first, remove the bolt that holds the actuator arm. Then withdraw the lube piston and spring from the base block. Next, remove the four set-screws (two 1/4-20 screws and two 5/16-18s — one on top of the other) that hold the lube-pump bushing in place in the base block. The set-screws are in the top of the base block, over the lube pump.

Insert a $\frac{3}{8}$-16 x $1\frac{3}{4}$-inch hex-head cap screw into the pump bushing. Using the head of the hex-head screw, pull the old lube pump out of the block. If necessary, pry the pump housing out by using two screwdrivers after first placing shims beneath them to avoid damaging the base block. Clean the excess lubricant from the block, then install the new lube-pump bushing. Be certain to align both the lube port and the set-screw holes before you press the lube-pump bushing into the block. If they are not perfectly aligned, remove the housing and start again. Tighten the set-screws to a snug fit. Do not overtighten them. Make certain the piston moves freely while you're tightening the set-screws.

Assemble the actuator arm and the piston without the spring, and make certain that there is not more than 1/64 inch of clearance between the pump actuator and the piston, with the piston bottomed out and the pump actuator at the highest point of the actuator cam. If this dimension is not correct, remove the piston, and grind material from the small end of the piston. Then recheck for the proper 1/64 inch or less of clearance between the pump actuator and the piston, with the piston bottomed out and the pump actuator at the highest point of the actuator cam.

Reassemble the piston, spring, and actuator arm, and the installation is now complete.

The Lube Master is a high-quality piece of machinery designed to give years of unfailing service to the commercial and professional bullet caster. If you give it the proper preventative maintenance and rigorously follow the few rules of operation, there is no reason that you can not lube and size many millions of bullets before you have to replace anything at all. The Lube Master is a perfect complement to the Bullet Master machine.

# 8

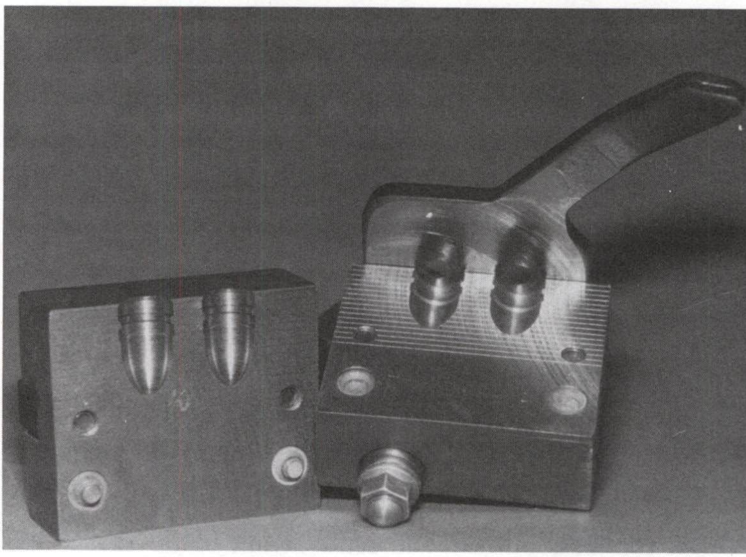
# *Molds and Mold Care*

MOLDS ARE THE life blood of any bullet-casting business, and they require the very best care and attention. There seems to be an endless selection of styles and weights for any given caliber, and new ones are introduced regularly. In addition, the most popular styles of bullets may not necessarily be the wisest choices for the new commercial bullet caster. It may be better to introduce a bullet style that is different from those your competitors offer. If you offer something new and different, you give the end user a greater selection, and you may help yourself to penetrate the market more readily.

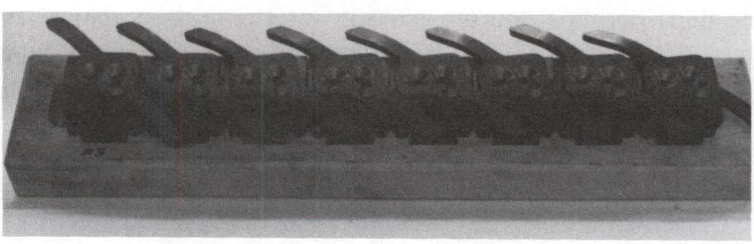
For example, if you are selling your bullets to a gun store for resale to individual reloaders, why would the store owner want to buy your 148-grain .38 wadcutters instead of his present supplier's similar bullets? You could of course sell yours for less, but do you really want to do that? You will earn less, and you'll develop the reputation of always selling for less. And some will wonder whether (or will conclude that) perhaps you are making inferior bullets. No, it is better to examine your market and select a style and bullet weight that are not being offered and sell your bullets for a competitive price.

For example, a 158-grain semiwadcutter would be almost as good a target bullet as a 148-grain wadcutter, but it can also be an excellent bullet for hunting small game. So if your bullet is as good as you competitor's, and more versatile, you may have a better over-all seller in an alternative bullet type or design.

How long you can expect your molds to last is another major consideration when you're selecting molds. Magma Engineering will adapt SAECO, RCBS, and Lyman molds to function on their machines — but (there is always a but)



*Magma Engineering makes its molds of high-quality, extra-hard cast iron for durability ...*



*... in matched sets of eight molds, with all bullet-forming cavities cut by the same cherry, for consistency in bullet weights and diameters.*

these molds are designed to be used by the hand caster who will seldom or rarely cast a million bullets in a lifetime.

Their molds are somewhat less expensive — at first — but a number of commercial casters who have used them on Magma casting machines have found that these excellent *low- to moderate-volume* hand-casting molds do not last nearly as long as the high-volume molds manufactured specifically for commercial bullet-casting machines by Magma Engineering Company.

Magma uses a harder, more durable, higher-quality material in the manufacture of their molds, because these are designed for the commercial bullet caster who needs molds that can reliably and consistently produce quantities of good bullets equivalent to the output from several long, active lifetimes of hand-casting. Remember, again, the cavities in the molds that other manufacturers make — though meant to cast bullets of exactly the same design — may or may not be produced from the same cherry. If that happens to be the case with the molds you buy from them, you will have a set of molds that cast bullets of the same design with a variety of dimensions, making it very difficult to maintain product quality. And if you do not maintain high quality in the bullets you produce, it will be quite easy for someone else to improve on what you do and thereby take away some of your customers.

If you elect to use another manufacturer's molds, be certain to order them yourself, and check them yourself before you send them on to Magma for adaptation. If they are not all precisely what you want, in every respect and dimension, return the unsatisfactory ones to the manufacturer for replacement until you do get exactly what you want. However, do not expect to get the same lifetime out of these molds, and be sure to figure this additional cost into your over-all operating expenses.

There are a multitude of cast-bullet nose designs, but there are only three basic base designs: the flat base, the beveled base, and the gas-check base. Both the flat base and the bevel base are ideal for the commercial bullet caster. The gas-check design presents numerous automation problems for the commercial bullet caster. The gas-check design works quite well if you don't have to install the gas checks — and indeed sometimes is superior to other designs if you put lubricant in the gas-check groove. It seems that the additional lubricant in the gas-check groove sometimes improves ballistic performance.

From the viewpoint of the reloader, the bevel-base design is superior. The bevel-base design allows the reloader to seat the bullet easier without shaving the sides of the bullet, thus improving ballistic performance. This is particularly important when reloading cartridges that headspace on the case mouth, when belling the mouth of the case for positive seating is not desirable. The bevel-base bullet simply starts into the case easier. Pistol cartridges that headspace on the rim (like the Colt .45, sometimes called the .45 Long Colt) can use the flat-base design, yet the bevel-base is still easier to start, even though the case can be belled substantially.

All new purchased molds other than Magma's arrive coated in a deep layer of oil or some petroleum-based preservative. Many of the old cast-bullet manuals say that the best way to remove this oil is by casting as if there were no oil present, until all the oil is burned off. Don't you believe it. The manufacturer puts preservative on his bullet molds because he has no idea how long the molds will sit on a shelf before they are used, and he does not want them to rust before they're sold.

The best way to treat the oil-soaked molds is to heat up a pan of boiling water with some detergent in it and to boil the molds. Immediately after the oil has been removed, rinse the molds in clear boiling water to remove all traces of the detergent, then dry them completely. If you leave any water on the mold, the mold will begin to rust at that spot. Be absolutely certain that all water has been removed from the mold cavity before you start to cast. If any water remains in the cavity when you begin casting, a small explosion will splatter molten lead everywhere. This can not only damage your machine but it can also severely injure you. Never allow moisture to remain in your molds.

If you begin casting with oily molds, the oil eventually burns off — but it leaves a carbon-base residue that will imprint all your bullets. This deposit is not only difficult to remove — it will take quite a long time before the mold will yield acceptable bullets.

I know of a novice commercial bullet caster who took this old advice a little too seriously with his .45 ACP molds. He not only began immediate casting with his oily molds, but at the end of each day, he thoroughly doused each mold in the set with oil. He did this thinking he was helping to prevent rust buildup. Naturally, the deposits of oil residue that he baked into the sides of the cavity started to build up after each daily burn-in, and it wasn't long before his .45 bullets resembled .22s of very low quality.

In addition, his production rate was unbelievably poor. When he finally complained about the problem, it was easy to solve, but the molds were extremely difficult to clean. So do not oil your molds. If you have to store your molds for some time without using them, place them in an air-tight container with a moisture-absorbing desiccant to prevent rust buildup. If this is not possible, and you feel compelled to oil them, use the boiling water and detergent to clean them before you cast with them again.

This procedure not only prevents premature mold failure — it also increases your productivity. The molds when thoroughly cleaned start to yield excellent bullets long before an oily mold does.

Another area that sometimes causes difficulty is the vent grooves. If you open a mold set and look at it carefully, you will discover that the mold blocks have small grooves cut into the mold face, leading to the bullet cavities. These are vent grooves, and their purpose is to allow air to escape from the mold cavities when molten lead is poured in. These grooves are typically only three to five thousandths of an inch deep. If these grooves become plugged with any foreign matter (including machining burrs), the bullets that you cast in the mold's cavity or cavities will not fill out properly. The mold will always cast poor bullets until you make sure the problem is corrected.

Since the vent grooves are quite shallow, great care is necessary when you have to clean them. It is very easy to damage them and thus ruin the mold altogether. You can use a small straight pin to gently scrape deposits from within the grooves. If you see burrs in the grooves, use a small jeweler's file to remove them. If the burrs appear to be above the grooves, you can carefully polish the mold face with 00 or 000 steel wool. You can also lay a sheet of 300- to 400-grit emery cloth on a pane of plate glass and polish the mold face to remove burrs. Do this carefully; your purpose is to remove the burrs, not to plane down the surface of the mold block. When you've completely gotten rid of all the burrs, apply a cold-bluing solution to the face of the mold block to inhibit rust.

The same procedure also applies if one of your molds casts bullets with fins on them. Fins are caused by either casting at too high a temperature or by mold blocks that are not closing properly. If any of the bullets dropping from your molds have fins on them, remove the mold (or molds) from the machine and examine the mold faces for burrs or foreign matter. Remove all burrs and foreign matter and reinstall the mold block.

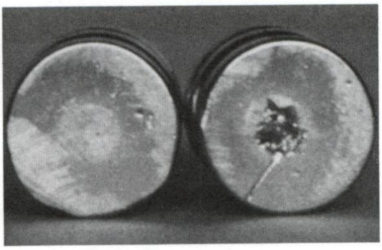
If the fins are mainly on the base of the bullet, the sprue plate is not functioning properly. Check the tops of the mold blocks to see whether lead deposits are forming between the tops of the mold blocks and the sprue plate. If lead has been smeared along the tops of the mold blocks, you are casting at too high a temperature. If the lead is still too hot when the sprue is automatically cut, the molten lead smears on the tops of the mold blocks.

As this deposit of lead builds up, it forces the sprue plate ever farther from the top of the mold, with detrimental results on your bullets. Remove the sprue plate and clean all the lead deposits off the mold top. Reinstall the sprue plate on the mold, lower the casting temperature, and begin again.

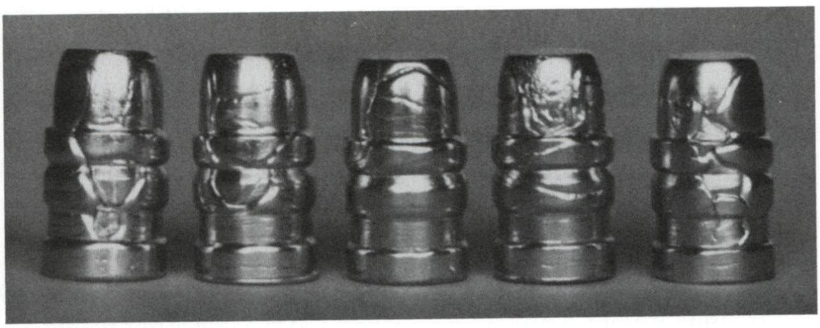
Another cause of base fins is overtightening the lock screw on the sprue plate. On some molds, this overtightening can warp the sprue plate and cause it to rise far enough above the top of the mold to allow molten lead to form fins. In an extreme case, these are not fins but more of a sheet or plate. To cast good bullets, the sprue plate must sit perfectly flat against the top of the mold. If the sprue plate does not sit perfectly flat when it's properly attached, then the top of at least one mold block is warped, or the sprue plate is warped. In either case, return the molds to the manufacturer for repair.

All of Magma's molds are tested by actually casting bullets with them before shipping them, and they'll cast outstanding bullets when you receive them. Thoroughly check any molds you purchase from other suppliers before you ship them to Magma to be adapted for use in your Magma casting machine.

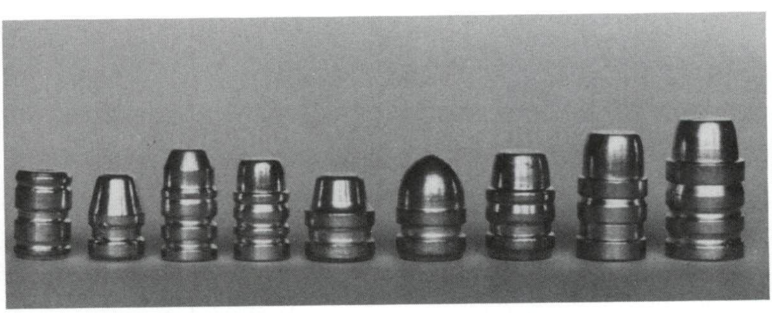
If you properly care for and feed your molds, they will cast millions of good bullets before they finally, like all things, succumb to old age and extended use. If you do not give your molds their necessary care, build this fact into your operating costs, because you will indeed spend more than you need to spend, by having to replace your molds more often.



*Their bases reveal that these aren't very good bullets. One base isn't round; the other has a cavity. Neither bullet is likely to be accurate.*



*Wrinkled bullets mean the mold isn't hot enough to cast good bullets. Put 'em back in the pot and keep casting.*



*The great variety of bullet sizes and styles also means a variety of "the best" alloys and casting temperatures.*

9

# *Essentials for Accuracy*

THERE'S NO POINT in going into the cast-bullet business if you don't intend to produce accurate bullets. Only accurate bullets will continue to sell and allow you to continue to expand your market. What I mean by accuracy is commercial accuracy, not custom accuracy. It is not possible for the commercial bullet caster to produce bullets custom-designed for each of his customers' guns. That would be much too time-consuming and prohibitively expensive. However, since the average gun is probably well suited to shooting cast bullets of nominal diameter or slightly larger, there is no reason for high-quality cast bullets not to perform well in almost every firearm.

As I've said in earlier chapters, selecting the proper alloy for your bullet metal is essential. It would be ideal if there were unlimited supplies of scrap Linotype metal available, but this situation no longer exists. If you find a good supply of Linotype, hang on to it. It won't be abundant for long. Those who have sizable quantities available usually sell it to foundries, which can and usually will buy the entire lot immediately.

A truckload lot of Linotype brings right around fifty-five cents a pound for a total cost of about $24,750 plus the freight. That is a pretty good-size bite for the beginning commercial bullet caster. Until you can get your sales up, you simply can not compete with a foundry. You see, the foundries look at it from two viewpoints. The first is obvious: scrap Linotype represents low-cost material for use in their own alloys. The second reason is that if they can buy it, they can keep it out of the hands of their potential competitors — including you. They would much rather sell you material that they have refined, alloyed, and cast than for you to do it yourself. After all, that is their primary business.

Therefore, as a rule, when you use specification bullet metal, you have to use a metal that's strong enough for your purpose. For example, if you cast 148-grain .38 wadcutters for a police department's practice shooting with .38 Special revolvers, you will find that a three-percent-antimony alloy does quite well in these low-velocity loads.

This is the same as scrap wheel-weight alloy. It is economical and readily available. On the other hand, if you cast bullets for high-velocity loads, with silhouette shooters as your primary customers, you must have a commercial foundry blend Linotype alloy for you. You will need all the strength you can get from a lead bullet, for these shooter-customers to get the kind of accuracy they must have to be competitively successful shooters.

As I've written earlier, once you have developed an alloy strong enough for a given load, it is imperative that you do not degrade that strength by oversizing the as-cast bullet.

This bears repeating. Any cast bullets that you oversize (that you size to more than a couple of thousandths of an inch smaller than you cast them) work-soften as you size them. Sometimes this oversizing can reduce the strength of the bullets by more than fifty percent. So try to get molds that cast bullets no more than two thousandths of an inch larger than the final, sized diameter of the bullets you want to sell. Not only does oversizing these bullets reduce their strength — it may also move metal into the critical base region of the bullets, which also greatly affects accuracy. Remember, all sizing moves metal. How much metal is moved and where it is moved are major concerns.

If you're just getting into the business of casting bullets commercially, it would be a good idea to use only bevel-base designs, at least until you have established a good reputation. One of the things you have no control over is your customers' loading techniques. If some of your customers shave the sides of the flat-base bullets you sold them, the bullets will be less accurate. They may very well blame the maker of those bullets for their poor performance.

Since the bevel-base design reduces the tendency of the seating process to shave the bullets, this base design increases your chances of having a satisfied customer by eliminating one of his problems. The proper formation of the bullet base is essential for an accurate bullet. The base is much more important to accuracy than the nose. For this reason, reject all bullets that have imperfections in or on their bases. Sort through all your production and return all bullets with malformed bases back into the pot for remelting.

While we're on the subject of remelting: if you are reclaiming scrap material, be sure to melt it and cast it into small ingots cast from some other pot, not in the one on your Bullet Master machine. This procedure will not only save you many problems with your Bullet Master later but will also help you keep your metal clean. Depending on the type of scrap you are using, you may not completely remove the dross on the first melt. If you have melted your scrap in a separate pot and have properly cleaned the metal, then remelted it in your Bullet Master pot and skimmed it before casting with it, then you most likely have the cleanest possible alloy in your bullets.

Examine your production bullets very closely for small black specks embedded in the bullet's surface. If you find some, your metal is not clean enough. These are called inclusions and indicate improperly prepared metal. Remelt it and clean it again.

As a rule, three-percent-antimony alloys are good enough for low-velocity bullets. Six-percent-antimony, two-percent-tin is good for moderate- and high-velocity bullets; and twelve-percent-antimony, four-percent-tin is best for very-high-velocity bullets. Naturally, only pure lead should be used for muzzle-loader balls. If the three-percent-antimony doesn't cast well in your particular mold set, try adding two percent tin to it (in the form of plumber's fifty-fifty bar solder). This added tin does not increase the hardness significantly, but it does greatly improve the castability of the alloy, casting better bullets. The bullets are lighter, too.

Another rule of thumb in casting circles is that the more an alloy is alloyed, the less it shrinks when it cools. This is useful to know if your bullets have to be excessively sized. A bullet cast of Linotype shrinks much less than a bullet cast of 6-2 alloy, or from pure lead, in that same mold. You can alloy down not only to increase bullet weight but also to increase shrinkage to minimize sizing deformation.

Usually, you can improve performance by using a softer alloy. Interesting, isn't it? The reduction in alloy strength can be offset by the increase in strength because of reduced sizing. Still, the best bullet of them all is the bullet that is cast precisely the required diameter and is passed through the sizing die merely to apply the bullet lubricant.

Lubricants also require the commercial bullet caster's careful consideration. There are dozens of brands of bullet lubricants available to the commercial bullet caster. And it is interesting to note that all of them work with one bullet or another or in one firearm or another. The primary problem for the commercial bullet caster is to find one that works effectively for all his production bullets, in all the firearms they're used in, and with every load developed by his customers. Now there is a tall order!

To date, I have found only one lubricant that has done all the above — Magma Blue, manufactured by Magma Engineering Company. Their business is producing equipment for the commercial bullet caster, so they have put a good bit of effort into developing a proper lubricant. Their customers' success is necessary to their success. A lubricant that is ineffective causes your customers to have trouble with severe bore leading, which also causes very inaccurate shooting at the least. And if you use a poor lube, your bullets will rightly be blamed for their inaccuracy, no matter how well you've cast and sized them.

It is undoubtedly possible to find a bullet lubricant that is a little less expensive than Magma Blue, but unless you are operating on a very thin margin indeed, the saving will not be worth the effort. Stick with the materials that eliminate problems, so that your business can grow steadily. If you need to cut costs, always remember that your most significant cost is always your raw material. Constant research in that area goes a long way toward reducing your costs and improving your profits.

Also be aware that the natural tendency for lead-based alloys is to either harden or soften with age. Lead-tin-antimony alloys slowly harden over the course of approximately three weeks; then their final hardness stabilizes. This age-hardening can affect the ultimate quality of your bullets, as the reloader sees it; so if it's at all possible, see to it that your bullets are at least three weeks old before they are sold for reloading.

If you allow samples of your bullets to be tested for either publicity or for evaluation by a shooter, by all means do not give out samples that you cast the day before. These bullets can be considerably softer than the same bullets would have been if they'd been allowed to age (and thus harden) for three weeks.

If the shooter who tests these bullets is looking for the maximum performance potential, there is a good chance that he will find these freshly cast bullets inadequate — at the cost of your reputation for making good bullets. The same testing conducted on bullets whose hardness has stabilized will yield far better results.

Tin-lead alloys either do not age-harden at all or in fact age-soften, depending on which specific alloy you use. For example, an alloy of five percent tin and the rest lead appears to maintain its low hardness without regard to time. A ten-percent tin-lead alloy becomes softer with elapsed time. A ten-percent tin-lead alloy is very nearly the same composition as the much-written-about and quite expensive one-ten tin-lead alloy.

With its relatively low hardness, high cost, and tendency to lose what little hardness it has, this alloy is a poor selection indeed for the quality-conscious commercial bullet caster. The best application for this alloy is to use it to add it (for its tin) to another alloy. *Any addition of more than two to three percent tin to any bullet alloy is really a waste of your money.*

With most publications today extolling the virtues of fluxing metals regularly, I have to point out that if your metal is properly fluxed when it is first made up, you don't have to flux it again unless it appears to be drossing excessively. Tin in your alloy forms a light tin dross layer on the top of your melt and inhibits further drossing if you keep the metal temperature below 750° Fahrenheit when you're casting.

Since most commercial bullet casters use bottom-pour pots, you need only skim and flux when it appears absolutely necessary. If you use clean metal and maintain the proper casting temperatures, for them, then your production is much less effort and your volume improves.

## *Heat-Treating Cast Bullets*

You can vastly improve the hardness and strength of your cast bullets by heat-treating them. This process is not economical and greatly slows your production — so if you heat-treat your bullets, charge a premium price for them. They cost more, and they're worth more. Depending upon which alloy you use, you can make your cast bullets more than two to three times as hard as the original bullets were, before you heat-treated them. But there are many practical problems as well as at least one pleasant side effect. The pleasant side effect is that you can make wheel-weight metal considerably harder than an alloy of six percent antimony and two percent tin. In most areas of the country, wheel weights should be considerably less expensive than other alloys that are more favorable without heat-treatment.

The problems with heat-treatment come from the extra steps — meaning extra time — that it adds to the production process. You have to put the already cast bullets into an oven and heat them to approximately 464° Fahrenheit, without damaging them, for about one hour — then immediately, while they're hot, dump them into a container of cool water (again, *without damaging them*).

The now heat-treated bullets are ready for sizing and lubricating. But of course there's a catch. If the heat-treated bullets are then sized at all, the sizing can reduce their surface hardness by as much as three hundred percent. It makes no sense at all to tediously heat-treat bullets, then ruin them by sizing them. If you intend to produce heat-treated bullets, you absolutely have to cast them to the diameter you want, then merely pass them through a sizing die about a thousandth of an inch larger than the as-cast bullet.

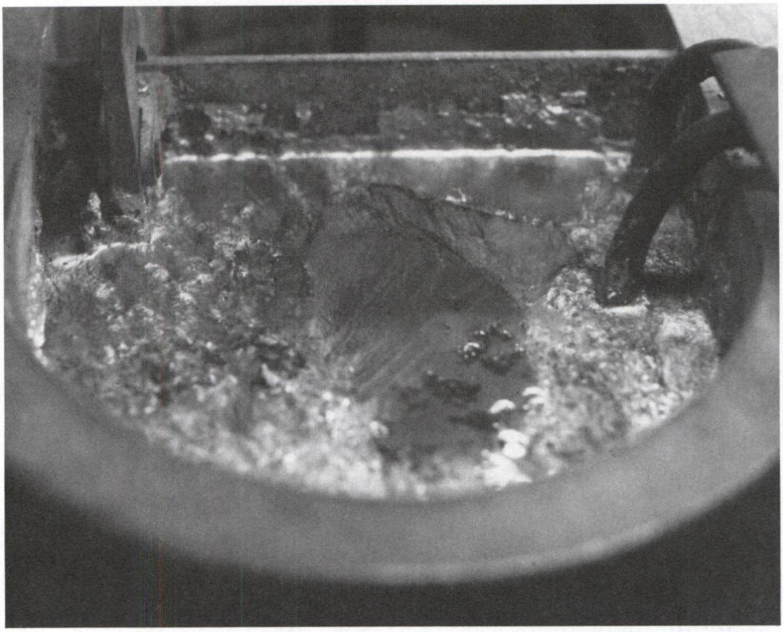
This procedure allows you to apply the bullet lubricant without the detrimental work-softening that comes with sizing. This effect is most pronounced in the hardest bullets.

To make matters even more interesting, only antimony alloys can be successfully heat-treated. Tin-lead alloys don't heat-treat well, and the more tin there is in the antimony-tin-lead alloys, the softer the bullets will be. As if all this were still not enough, a trace of arsenic — about five hundredths to twenty-five hundredths of one percent — must be present for successful heat-treatment. Any less than about five hundredths of one percent arsenic can lead to a less than optimum heat-treatment, and any more than about a quarter of one percent can produce bullets that can crack across the grease grooves.

If you use wheel-weight alloy as a base alloy for your bullet metal, you already have about fifteen hundredths of one percent arsenic in your metal. You don't have to add any arsenic. If you use other alloys, test heat-treat a few sample bullets first, and if the heat-treatment is unsuccessful, add no more than a tenth of one percent of arsenic to your alloy in the form of scrap lead shot, which you can probably purchase from a local trap-and-skeet range for much less than new shot would cost.

The shot you collect will be of the hard variety and will contain between 1.25 and 1.50 percent arsenic metal, so add no more than about one part shot to fifteen parts of base metal. If an error is to be made, it is best to be conservative when you use lead shot, as almost all other scrap lead alloys contain at least a small amount of arsenic already.

Gradually (over the course of several years), heat-treated bullets begin to age-soften. From the commercial caster's point of view, this softening is not important — if he has not sold his inventory after two years, he is probably no longer in business. Again, it is quite difficult to justify heat-treating cast bullets from a commercial viewpoint, but it is indeed one way to make the very finest cast bullets available to your customers.



*Dross is a natural, inevitable by-product of cleaning lead-based alloys. It has to be removed and disposed of properly but — in commercial quantities — can be sold.*

# 10

# *Alloying and Refining Metals for Cast Bullets*

ONE OF THE MORE interesting aspects of casting bullets is the opportunity for the bullet caster to select and construct a host of bullet alloys for himself, much the same as he can cast bullets in many weights and styles. Given the variety of molds available for any given caliber, and three or four types of alloying materials, the commercial bullet caster has what seems to be an infinite number of possible combinations from which to make his eventual selections.

In fact, you can design and blend — or have a foundry blend for you — a repertoire of metals to meet the specific demands of the different bullets you cast — inexpensive soft alloys for low-velocity revolver bullets, harder ones for high-velocity revolver and autoloader bullets, the hardest possible alloys for rifle bullets, with variety in each main category if you like.

With nothing more than a sharp pencil, an electronic calculator, plenty of paper, an accurate scale, and reasonably certain knowledge of the composition of the materials at hand, you can construct any bullet alloy you want, without exceeding the limitations of average intelligence and everyday equipment. But before we launch into a treatise on the specific mathematics for this figuring (don't panic; it's simple), it is wise to look at a few of the ground rules. These rules seem obvious enough when you look at them, but you can save yourself a considerable amount of frustration if you take them into account before you try to solve any alloy equation. First, your results will be no more precise than the true analytical values of the materials you use. In other words, if you don't know the composition of the materials that you are using, you won't know what you have produced when you have mixed them.

Second, for each element — antimony, lead, tin, *etc* — at least one of the materials that you are using must contain at least as much of that element as you want to be present in the final alloy.

For example, if you want to make some of Lyman's number-two alloy — five percent antimony, five percent tin, and ninety percent lead — you must have at least one material that will supply five percent antimony, one material that contains at least five percent tin, and at least one material that contains no less than ninety percent lead. Of course, it is possible to find materials that contain both antimony and tin in concentrations greater than five percent of each element in the same material.

Finally, even though your materials meet both of the above criteria, this is no guarantee of success. It is simply a matter of the proportion of the elements in the source materials as they relate to each other and to the desired composition of the final alloy.

You still may not be able to make what you want with what you have. Probably one of the nicest things about these formulas is that you can use them to determine whether you can use each of the materials you're thinking about using, to get what you want, before you buy it or try it.

You can tell, before you buy any of it, whether a certain material won't do at all — and you can tell which of two or more materials will be better for your purpose, therefore saving yourself some unnecessary expense. You can tell whether the material is the right one to use, before you start mixing it with something else, saving yourself unnecessary expenditure of time and trouble as well as protecting your usable material from contamination with worthless material.

The very first step in setting up the problem for solution is to mathematically define the materials at hand. For these examples, we are going to use three materials — Linotype, cable lead, and fifty-fifty bar solder — to construct a supply of Lyman number-two alloy. Note that the Linotype contains more than five percent antimony, the cable lead more than ninety percent lead, and the fifty-fifty bar solder more than five percent tin. The Linotype in this example contains eleven percent antimony, four percent tin, and eighty-five percent lead.

The cable lead contains 0.50 percent antimony, 0.10 percent tin, and 99.40 percent lead.

The fifty-fifty bar solder contains 0.30 percent antimony, 50.0 percent tin, and 49.70 percent lead.

And of course the Lyman number-two alloy will contain — if we do this right — five percent antimony, five percent tin, and ninety percent lead.

Next, give each material an algebraic symbol to represent it in the equations. For this example, we are going to call Linotype $x$, cable lead $y$, and fifty-fifty bar solder $z$. Any other letter that you may prefer will do, as long as you use three different letters for the three different materials — and keep straight which letter stands for which material, of course. Jot down a note to yourself — something like "Lino x, cable y, 50/50 z," to keep things straight.

Now it is necessary to decide just how much of the final product you're going to produce. One thousand pounds is a good quantity. You can easily divide it by ten to yield one hundred pounds or divide it by a hundred to yield a ten-pound batch for experimentation. This procedure saves calculation time later, and the ratios are the same.

To set up the first of our equations to find what we don't yet know, we use first what we do know — that we must mix together an unknown amount of Linotype (*x*), plus an unknown amount of cable lead (*y*), plus an unknown amount of fifty-fifty bar solder (*z*) to equal a thousand pounds of Lyman number-two alloy. So the first equation is simple enough:

$$x + y + z = 1{,}000$$

Now we know that a thousand pounds of Lyman number-two alloy contains five percent antimony, so there must be fifty pounds of antimony (five percent of a thousand pounds). It also contains five percent tin, which also means fifty pounds. Lead at ninety percent would yield nine hundred pounds.

All this added together (50 + 50 + 900) equals a thousand pounds of the alloy that we are theoretically going to make. Since *x*, *y*, and *z* represent single materials but with three elements in each of these materials, it is proper to define each in terms of its components. (*Sb* is the chemical symbol for antimony, *Sn* for tin, and *Pb* for lead.)

$x = 11.0\%\ Sb,\ 4.0\%\ Sn,\ 85\%\ Pb$

$y = 0.5\%\ Sb,\ 0.1\%\ Sn,\ 99.4\%\ Pb$

$z = 0.3\%\ Sb,\ 50.0\%\ Sn,\ 49.7\%\ Pb$

The next step is to remember that all these figures are percentages, and they all must be converted to decimals — simply divide by a hundred (move the decimal two places to the left, and add a zero to the left of single-digit percentage numbers) — so that 11.0 percent antimony becomes 0.11, tin is now 0.04 instead of 4.0 percent, and so on for each percentage figure. From this point on, we will be setting up the linear equations and solving them. Since we have three materials, each with three elements in it, we need three equations — one for each element. The first equation, for the amount of antimony we need, is this:

$$0.11x + 0.005y + 0.003z = 50 \text{ pounds antimony}$$

This equation means that we want the 11.0 percent of antimony in the Linotype ($x$), plus the 0.50 percent of antimony in the cable lead ($y$), plus the 0.30 percent of antimony in the fifty-fifty bar solder ($z$), to equal fifty pounds when we add them all together in the correct proportions.

Next, we write the same kind of equations for the fifty pounds of tin and the nine hundred pounds of lead we'll need for our final mix:

$$0.04x + 0.001y + 0.50z = 50 \text{ pounds tin}$$

$$0.85x + 0.994y + 0.497z = 900 \text{ pounds lead}$$

Then put all three of these equations together to keep them straight.

$$0.11x + 0.005y + 0.003z = 50 \text{ lb antimony}$$

$$0.04x + 0.001y + 0.50z = 50 \text{ lb tin}$$

$$0.85x + 0.994y + 0.497z = 900 \text{ lb lead}$$

When we have these three equations properly expressed, it is time to start solving for the amount of one of the materials that we will need to use to make a thousand pounds of the final alloy. Start by selecting two of the three equations to work with. It doesn't make any difference which two of these equations we use first, but it is a good idea to start with the first two, because we can get confused easily enough without forgetting which two equations we started with. Simply rewrite the first two equations (called *a* and *b* for reference) without the third:

$a: 0.11x + 0.005y + 0.003z = 50$

$b: 0.04x + 0.001y + 0.50z = 50$

Now the objective is to eliminate $x$, $y$, or $z$ from one of these equations — and then to combine the two equations by either adding one to (or subtracting it from) the other, to give one equation with two unknowns instead of three.

One of the basic rules of algebra is that you can do anything mathematical to an equation if you do the same thing to both sides of the equation, and the equation is still valid. For example, start with the equation 2+2 = 4. One side of this equation is 2+2, and the other side is 4. If we divide one side (2+2) by two, we have to divide the other side (4) by two also. The result is 1+1 = 2, which is just as true as 2+2 = 4 and is exactly proportional to 2+2 = 4.

Another basic rule of algebra is that we can use more than one kind of symbols for multiplication:

$2 \times 2 = 4$

or

$(2)\ (2) = 4$

This second form, using parentheses for numbers that we are going to multiply, comes in especially handy when the parentheses include more than one number — for example, when we have several numbers that we have to add up first, and will then multiply by the resulting number:

$$2\,(1 + 1 + 1) = 6$$

This equation is exactly the same mathematically as the equation 2x3 = 6. Also, (1+1)(1+1+1) = 6 is mathematically the same as 2x3 = 6.

Now let's do something of the sort with our two alloy equations. Let's multiply equation *a* by 0.04 and equation *b* by - 0.11, then add them together, thus eliminating *x* from the resulting equation:

$$(0.04)\,(0.11x + 0.005y + 0.003z = 50)$$

$$(-\,0.11)\,(0.04x + 0.001y + 0.50z = 50)$$

These multiplications give us two new versions of these two equations:

$$0.0044x + 0.0002y + 0.00012z = 2.0$$

$$-\,0.0044x - 0.00011y - 0.55z = -\,5.5$$

Adding these new values for *x*, *y*, and *z* gives us another new equation (call this one *d*):

$$d\!: 0.00009y - 0.5488z = -\,3.5$$

(The 0.0044x in equation *a* and the - 0.0044x in equation *b* have just canceled each other out; in doing so, they have eliminated *x* from equation *d*).

Next, let's take the second pair of basic equations and give them the same treatment, again to eliminate *x*. Multiply equation *a* by 0.85, and multiply equation *c* by - 0.04:

$$a\!: (0.85)\,(0.04x + 0.001y + 0.50z = 50)$$

$c: (-0.04)(0.85x + 0.994y + 0.497z = 900)$

These multiplications again give us two new versions of the two equations that we started with:

$0.034x + 0.0085y + 0.425z = 42.5$

$-0.034x - 0.03976y - 0.01988z = -36.0$

Now adding the two new values in these two equations allows us to eliminate *x* again, since 0.034*x* cancels out the -0.034*x*, and we have another new equation — with only two unknowns rather than three (let's call this equation *e*):

$e: -0.3891y + 0.4051z = 6.5$

Now we have two equations, *d* and *e*, each with only two unknowns; we go through the same kind of routine with these two equations, this time to eliminate *y* from the next new equation. We multiply equation *d* by 0.03891 and multiply equation *e* by 0.00009:

$(0.03891)(0.00009y - 0.5488z = -3.5)$

$(0.00009)(-0.3891y - 0.4051z = 6.5)$

Equation *d* now becomes

$0.0000035019y - 0.0021353808z = -0.136185$

and equation *e* becomes

$0.0000035019y + 0.0000364608z = 0.000585$

But this time, we subtract equation *e* from equation *d* to eliminate *y*, as we have already eliminated *x*, and we find ourselves with yet another new equation (let's call this one equation *f*):

$f: -0.00209892z = -0.1356$

Since we need a positive value, we can now multiply both sides of this equation by -1 (simply change the signs on both sides of the equation) to give us

$0.00209892z = 0.1356$

The rest is easy: divide both sides of the equation by 0.00209892*z*, or divide 0.1356 by 0.00209892 (same thing), to find that

$z = 64.6047$

Since *z* represents fifty-fifty bar solder, solving this series of equations reduces all those figures for *z* to the one that we need to know: that making a thousand pounds of Lyman number-two alloy will need 64.6 pounds of the fifty-fifty bar solder.

Here, it is good to realize that if *x*, *y*, or *z* reduces to a negative number, you have a problem that you simply can not solve — you can not make the alloy you want from the materials that you want to use for its ingredients. There is no point, when you find yourself in this situation, in going further — a negative quantity for any element indicates that you have to *remove* some antimony, lead, or tin from one of your materials to get the correct proportion for the alloy that you want to produce.

The next phase in solving the equations is done in the same way as in the phase that we just completed, except that now we eliminate *y* and solve for *x*. Multiply equation *a* by 0.001 and equation *b* by - 0.005

$a: (0.001)\ (0.11x + 0.005y + 0.003z = 50)$

$b: (-0.005)\ (0.04x + 0.001y + 0.50z = 50)$

to produce the equation

$- 0.00009x - 0.002497z = - 0.20$

Now, we multiply equation *b* by 0.994 and equation *c* by - 0.001:

$b: (0.994)\ (0.04x + 0.001y + 0.50z = 50)$

$c: (- 0.001)\ (0.85x + 0.994y + 0.497z = 900)$

to produce the equation

$0.3891x + 0.496503z = 48.8$

and then, to eliminate $z$,

$(0.002497)\ (0.03891x + 0.496503z = 48.8)$

$(0.496503)\ (-\ 0.0009x - 0.002497 = -\ 0.20)$

to produce the equation

$0.000053473x = 0.022553$

Dividing by 0.000052473 reduces this equation to

$z = 429.8019$

Which means that the required amount of Linotype ($x$) required to make our thousand-pound batch of Lyman number-two alloy is 429.8 pounds.

Our very first simple equation was $x + y + z = 1{,}000$ — so if we subtract our known values of $x$ and $z$ from 1,000, the only thing left has to be the necessary amount of cable lead ($y$):

*1,000.0 lb number-two alloy*

*- 429.8 lb Linotype*

*570.2*

*- 64.6* lb fifty-fifty solder

*505.6 lb cable lead*

Of course, after we've gone through all this, we have to check our results to see whether this combination of raw materials does in fact produce a mixture of alloy that contains the fifty pounds of antimony, fifty pounds of tin, and nine hundred pounds of lead we need. The way to check is simple: multiply the decimal percentage of each element by the weight of each material, then add up all the resulting figures:

*429.8 lb Linotype = 47.3 lb antimony (11%)*

*17.2 lb tin (4%)*

*365.3 lb lead (85%)*

*64.6 lb solder = 0.2 lb antimony (0.3%)*

*32.3 lb tin (50.0%)*

*32.1 lb lead (49.7%)*

*505.6 lb cable = 2.5 lb antimony (0.50%)*

*0.5 lb tin (0.1%)*

*502.6 lb lead (99.4%)*

*1,000.0 lb number-two alloy*

There are many advantages in being able to set up and work out these equations. If you have a list of raw materials, their composition, their costs, a pencil, paper, and a calculator, you can explore the world of precise alloying.

When you know what each material costs and how much of each you're going to blend to make a final specific product, you can simply derive the cost of making your own alloy. Alloying is really nothing more than following a recipe. Simply define just which cast-bullet "dish" you want to make, then write up your own recipe with these equations.

## *Refining*

Refining, as opposed to alloying, is what you do to your bullet metals after you have alloyed them, to condition the alloy into the best possible shape for casting into bullets. In other words, it is what you do to the metal to clean and remove impurities, including any "tramp" elements.

Bullet casters usually do this by fluxing the metal with some type of commercial flux, then skimming off and discarding the dross that rises to the surface of the molten alloy.

Commercial refiners call this "dry drossing," and they usually do it by adding a layer of dry sawdust to the surface of the metal, stirring it well into the metal, and then skimming the dross off the metal. After dry drossing, the material needs what is called a caustic treatment. Now this really cleans the metal!

However, the caustic material, sodium hydroxide, is extremely corrosive and needs to be handled with the utmost care. The correct form of the caustic material is in pellets about the size of a pea.

You can get sodium hydroxide from most any chemical-supply distributor, and if you decide to add this step, you need to get just enough to cover the top of the metal in the pot after it has melted. Sodium hydroxide is hydroscopic. This means that it readily absorbs water — right out of the atmosphere. And anyone who has worked with molten metal will tell you that adding water causes a most unpleasant reaction. Sometimes, an explosion sends molten metal everywhere. Use extreme caution. Always store your sodium hydroxide in the container it came in when you bought it, and always keep it covered when you're not using it. Always store it in a dry place where no water will come into contact with it.

To treat molten lead with the caustic (sodium hydroxide), spread it on the surface of the molten metal — *do not agitate the metal* — until it melts. Add enough so that the melted caustic just covers the surface. It will be easy to see, as it will be quite shiny and will look wet. Any water that the caustic has absorbed evaporates after a few minutes and eliminates the possibility of a violent reaction.

Be extremely careful not to touch the caustic material, either in its natural form or in its molten form. It is extremely corrosive and burns just as readily as a strong acid. For this treatment, the metal temperature should be between seven hundred and eight hundred degrees Fahrenheit.

Once the caustic is melted, and you're certain that all water has evaporated from the surface, vigorously stir the melted caustic into the molten lead alloy. This stirring is quite important if the metal is to be truly cleaned up. After several minutes of stirring, you can skim off the resultant dross (caustic dross) and dispose of it. Next, although this step is not absolutely necessary, you should remove the caustic chemical from the alloy — spread about half an inch of fine charcoal on top of the molten metal, stir it into the metal, then skim it off. Now, if there is no adverse element in the alloy, it is ready for casting.

If there is an excessive amount of copper in the alloy, you might have trouble casting anything with it, and you might have excessive amounts of dross. You can selectively remove copper from any lead alloy by adding sulfur while you keep the alloy at liquidus. (Liquidus is that temperature where the alloy is barely molten. It is the boundary between solid and liquid.)

To remove copper, lower the temperature of the molten alloy until it just starts to form a solid ring around the edge of the pot. Estimate the amount of copper in the metal. For example, if you think that the metal contains about one percent copper, and you are using a hundred-pound pot, there is about a pound of copper in the metal.

One pound of sulfur removes one pound of copper, so add one pound of powdered sulfur to the top of the molten metal and stir it into solution. Skim off the copper dross that comes to the surface, and discard it. Then go ahead with the caustic and the charcoal treatments. Occasionally, you might find that your alloy is contaminated with zinc, aluminum, or calcium. The treatments for selectively removing these elements are extremely difficult and very dangerous. They produce by-products that under ordinary circumstances can generate highly toxic fumes — which can severely injure or even kill you. I'm not going to present these procedures here, because simple dilution with other metals is a much more acceptable alternative.

If after you've cleaned and treated your material, it just won't cast bullets, it's probably contaminated with aluminum, zinc, or calcium. The best procedure to use, for both economy and safety, is to cast the material into small ingots and blend it into another lot, taking care not to exceed a ten-to-one ratio (mix no more than one part of the contaminated alloy into ten parts of uncontaminated alloy).

Make up one lot and test it for castability — if it still doesn't cast, increase the dilution until it does. The commercial fluxes that are available do not work nearly so well as the procedures I've just given you. These are the procedures that the lead industry uses.

One last thing — all drosses that include lead are classified as hazardous wastes, so be sure to dispose of them properly, according to disposal regulations. I'll have more on this subject for you, in a later chapter, because you can not only dispose of it properly at no cost to you, but you can even get paid for it.

Getting paid for your waste can certainly help make your business more cost-effective.


*The huge **Thomas Register**, a standard business reference, is one source for locating metals suppliers.*

## 11

# *Finding Metals Suppliers*

IF YOU'RE JUST getting into commercial bullet casting, you'll be wise to find a lead foundry to manufacture specification metals for you. Even if you don't buy anything from the foundry immediately, it is still a good idea to become acquainted with producers in your area — to determine what metals are available, to get cost estimates on them, and to get an idea of the freight costs and delivery times you can expect. If you get a large order for bullets, you need to have a supplier of metal whom you can count on to produce the quantities of metal that you'll need — quantities that would be difficult for you to make up for yourself.

For example, could you — as an independent bullet caster just getting your business under way — produce a ton of metal a week, while you're also casting, lubricating, sizing, packaging, and delivering sixty thousand bullets? This is a considerable production for a beginning commercial caster, but it is not unheard of. Having a company handy to supply the necessary raw material for quoting can make it possible for you to develop accurate costs as well as help when your production rates just barely meet your customers' demand for all those superb bullets you're making.

To know whether the manufacturer is quoting you a reasonable price for the alloy you need, you'll have to understand a few things about the lead business. First of all, any lead plant that exists is not going to sell you anything unless it can make a profit by selling it to you. So don't expect to pay scrap prices for any lead alloy that has been refined, alloyed, and cast into ingots just for you.

The plant's pricing system is based on the international metals market, and that market changes every day for one or more of the elements in the alloy. For example, if you want to purchase an alloy containing six percent antimony, two percent tin, and the rest lead, the salesman at the lead plant first checks to see what the international market's prices are for the three elements in the alloy you're asking about.

Let's suppose that on the international market, antimony is $2.00 a pound, tin is $4.25 a pound, and lead is $0.42 per pound. Now these prices are for relatively pure metals, and they reflect the foundry's purchase price in truck-load quantities. Let me repeat that, because it is very important. These prices are for minimum purchases of twenty tons of each metal. And in some cases, freight costs must be added on top of these costs, usually from a supplier in New York.

Now the salesman takes the antimony price of $2.00 per pound and multiplies the concentration in your alloy by that figure (by 0.06 for six percent) to come up with $0.12 for the antimony, then he does the same for the tin (0.02 x $4.25) to come up with $0.085 per pound in your alloy, and finally, he does the same for the lead (0.92 x $0.42) to come up with $0.3864 per pound for the lead.

Then he adds all this together to come up with the base price for your alloy: $0.5914 per pound. This price reflects what his cost would be for the metals, without including the freight costs, if he has to manufacture your alloy from pure metals. This price does not include his cost to actually melt the material down, then to refine, alloy, and cast it into ingots. These costs would be additional and would depend on the ingot size you request. As a rule, the smaller ingots cost more, simply because it takes longer to cast out a given lot of metal into small ingots than into large ones.

Of course, the manufacturer doesn't make any alloy out of primary metals unless the specification demands it, to limit the number and amounts of residual elements, or because you specifically request it. If you ask for an alloy made up from essentially pure metals, expect the price to be considerably higher — simply because the foundry has no metal margin to play with. The metal margin is the difference between (a) the cost of producing the alloy using scrap materials and (b) the cost of producing the same alloy using primary materials. In either case, the manufacturer can sell the alloy to someone for what is called "full metals." Full metals is the cost of any specific alloy, expressed by the current metal-market prices for its constituents.

What does this mean to the commercial bullet caster? Well, first, any alloy that the lead foundry can produce from secondary materials (scrap) is just as good for casting bullets as bullet metal made from primary materials — if it is properly refined. And you will find, with rare exceptions, that all foundries do a proper job of refining.

The other area to be concerned about is the unnecessary specification of residual elements and overly tightening the specification for the primary elements required. For example, zinc, calcium, and aluminum are three residual elements that you should be concerned about, and it is right and proper that you should specify no more than 0.001 percent of any of these in any bullet alloy you want. If there's an excessive amount of these elements in your bullet alloy, you can't cast even mediocre bullets with it, and you should be able to have recourse to have the foundry make the alloy good.

On the other hand, elements like nickel, iron, bismuth, and a host of others aren't present in any significant amount (not enough to hurt bullet casting, which is the only use you're concerned about), and specifying a maximum just requires the foundry's lab to make additional analyses and to use only primary metals, which would thereby greatly and unnecessarily increase your cost. You'll find that it pays to be reasonable in your specifications. You can get good bullet metals at fair prices.

When you specify the major elements of antimony and tin (lead is always the balance), give the foundry a little latitude. It is impossible for the foundry to hit the assay smack on the nose. Even if the certification says they did, no two labs that analyze it will agree down to the last gnat whisker. So for these two elements, give the specification with a tolerance of about plus or minus 0.25 percent. For example, if you want a nominal six percent antimony in your alloy, specify 6.00 percent *Sb*, plus or minus 0.25 percent.

The same applies to the tin content. If you want two percent tin in your bullet metal, specify 2.00 percent *Sn*, plus or minus 0.25 percent. This latitude keeps everybody honest and helps to keep the cost of your alloy down. Remember, alloys with tight or impossible specs cost more but aren't necessarily any better for casting bullets.

The size of your ingots also helps to determine what your cost will be. Ask for quotes on the largest size your pot can handle (probably about a twenty-five-pound ingot) and on others smaller, down to the smallest practical size (probably about five pounds). Then you can decide for yourself what it is worth to you to have whatever you may decide is the ideal size or the best compromise. How much is it worth to you, for example, to save on heavier, less handy ingots, or to pay more for smaller, handier ones? You may be certain that all the prices the foundry quotes you will be for the cost of the alloy picked up at their factory. Also, don't expect the foundry to be ecstatic about doing business with you if you are asking for a quote on just one ton.

Remember, lead plants think in terms of truck-load quantities, not in one-ton lots. In fact, most lead plants have only one or two pots that are small enough to handle only one ton, and they frequently use them just for making up samples. The freight on one ton can have a profound effect on the price of your alloy. If possible, try to make arrangements to pick it up yourself. It is not unusual for the freight cost to add twenty-five cents a pound or more to the final cost of an alloy delivered to your facility.

Another thing to consider is timing and your ability to receive a shipment delivered by a semi truck. If your order comes by drop shipment by a common carrier, you might get it weeks after your order is ready at the foundry. It is not hard to conceive that this might cause some problems in your delivery schedules.

Another point to consider carefully, before you place an order with the lead foundry, is that almost all lead plants carry an inventory. And depending on what alloy you prefer to use for your bullets, the lead plant may very well have an alloy already in finished stock that will do quite well. For example, suppose you are casting round balls for muzzle-loaders. This is nothing more than corroding-grade lead, and the plant should already have large quantities of it on hand.

Unfortunately, their stock is in the form of hundred-pound ingots that they have purchased from the primary producers (mines). Few commercial casters have melting pots large enough to accommodate hundred-pound ingots. However, most lead producers remelt this primary lead into twenty-five-pound segmented ingots for the plumbing industry, and in this form it is ideal for bullet casters.

Many pistol shooters prefer an alloy popularly called "one-ten" or "one-in-ten." This alloy has roughly ten percent tin and ninety percent lead. If your foundry also produces bar solder or wire solder, they may very well have on hand in inventory an alloy called 10/90. This alloy contains ten percent tin and ninety percent lead and is an ideal substitute for one-ten alloy. (Using the same kind of popular term for it, you can think of it as "one-nine" alloy — not far from one-ten.)

Frequently, you can get better prices by purchasing an existing alloy that is already on hand instead of having the foundry produce a custom alloy for you. Decide what it is that you want, and ask them whether they have anything on hand that is close. If they have something, ask them for an analysis, and see whether it will suit your purposes. You should always be able to ask for and receive a certificate of analysis. And as a rough guide, any price you receive from a foundry that is more or less equivalent to the current metals-market price for a specific alloy is a good price. You will be hard-pressed to find a better price from any competitive foundry. A price that is equal to the primary value of the metals-market components means that the foundry has a good supply of the right kind of secondaries, which they've purchased at a good price. They rarely sell these materials to you at less than the full market price, since they can certainly sell them to someone else for the full price.

If you elect to process your own raw materials, there are a few places that you should approach and a few guidelines that you should follow for estimating the value of the materials they may have on hand. The specific alloy that they have is of the utmost importance, but they may or may not know exactly what it is that they have.

### *Radiator-Repair Shops*

Radiator-repair shops have good supplies of 20/80, 30/70, or 40/60 scrap solder that they have recovered from the repair of radiators. This material is quite drossy and includes significant quantities of iron oxide (rust from the radiators). The rust is a waste product for you and can be skimmed off when you process the solder scrap.

You can recover only about eighty percent (or less) from the processed radiator scrap, and you must consider this factor when you submit a quote to purchase. If you pay forty cents a pound for a hundred pounds of scrap solder ($40.00), you're really paying *fifty cents* a pound for the eighty pounds of it that you can actually use to cast bullets.

This solder is an excellent source of tin (after it's processed), but you should cast this material into very small ingots so that when you want to blend this with other materials, it will be easier to hit the weights that you've calculated.

### *Scrap Yards*

Scrap yards are another good source of scrap lead material for your bullet-casting operation. However, not all scrap yards know precisely what alloys they may have at any one time. It is up to you to know what it is you are buying and what alloy it is. As a rough guide, you can expect to pay about sixty percent of the full-metals price for any alloy that they may have on hand. For example, if the scrap dealer has a five-hundred-pound bucket of wheel weights, and the price of lead on the metals market is forty cents a pound, expect to pay about twenty-four to twenty-five cents a pound for his scrap. Any price that's much over this figure is too high — and if he quotes you any price much lower, buy it before he changes his mind.

You can also purchase wheel weights, sometimes, directly from tire shops — but their quantities are normally somewhat smaller than a scrap dealer's. However, they are worth a try, and they frequently sell wheel weights for less than the dealer charges, and they sometimes even let you have them free just for getting them off the premises.

Linotype is much desired by all bullet casters and is always quite rare. Anytime it can be purchased for sixty percent of its full metals-market price, it is a bargain. You can mix it half-and-half with any other low-antimony, low-tin alloy to bring the per-pound price down without degrading the quality of your cast bullets significantly. However, remember the chapter on scrap alloys, and be sure you are getting

Linotype, or at the very least be able to identify which version of type metal you do have.

The above are the major suppliers for raw materials. However, keep your eyes open for old buildings that are being torn down, as they are potential sources of lead pipe and sheet lead. Older buildings used pure-lead pipe in their plumbing, and many of the newer buildings use sheet lead in the walls as a sound attenuator. All these materials are most likely pure lead, and you should be able to buy it for a pretty good price just for removing it from the site.

### *Disposing of Dross*

Finally, remember that the more alloy you process yourself, the more dross you create. These drosses have to be disposed of. Now, and forever more, these drosses are classified as hazardous waste. They are not to be disposed of anywhere other than a hazardous-waste dump. But you can sell them to a foundry that can smelt them.

The latter is obviously the better alternative. If you have a significant volume of production, you eventually collect a significant amount of dross. Collect all this material into 55-gallon drums, and you will be able to sell it to a smelting lead foundry. You won't get much, but it's much better than paying to dispose of it in a hazardous-waste landfill.

In summary, it is more expedient for you to purchase alloy from a foundry than to make it yourself, although it is much more costly. However, you will produce considerably less dross, and your total production rate will be faster. Ideally, you should keep both avenues open to enjoy the best of both worlds.


*Sales can improve considerably after you send news releases (with good photos of your bullets) to shooters' publications and sample bullets to their writers.*

12

# *Finding Customers*

IF THIS CHAPTER doesn't command your attention, congratulations. You must be doing very well indeed, if you're not terribly interested in how to find new customers. There are many ways to organize your search for customers, but before you embark on a marketing plan, you may find it is best to determine just who your primary customers are going to be.

For instance, are you going to sell direct to the handloader who will use your bullets? Are your primary customers dealers who stock large and varied supplies? Or are you going to try to break into the high-volume, low-margin world of distributors?

There are advantages and disadvantages to each of these options. Sales to individuals bring in a great many smaller orders, each of which has to be handled and shipped separately. Packaging, handling, time, shipping, and advertising and promotion costs are all higher. The advantages are that you have a great many customers, and no one customer can upset your financial base. In addition, there is no middle man for you to have to support. That means you get a higher price for your products. Actually, it means that you get to keep more of the final selling price. As in all marketing, the selling price to the consumer is dictated by whatever competition exists in your marketing area. If the product is marketed directly to the end consumer, no distributor or dealer will require that you lower your selling price to allow them a profit margin. Of course, if you are successful, you ship many small orders and receive many small checks, too.

Dealers and distributors usually want to deal with you on extended terms, and this can cause what in business is termed negative cash flow. In short, unless you have considerable cash on hand, it can hurt you. However, it sure is nice to sell a hundred thousand bullets to one company and get that one large check for them.

If you're a beginning commercial bullet caster, it would probably be best if you call on every local gun dealer who sells reloading components. The individual price per hundred will be lower than if you sold them to individual reloaders, because you have to allow a profit margin for the dealer. However, the dealer will more than likely take a larger supply than any individual would ever order. Also, he very likely has many customers and will take a wider selection than any individual customer wants.

Go to every gun show and shooting event that is within your anticipated marketing area. Take lots of bullets with you, and if your prices are reasonable, you will sell many bullets while you make yourself and your products known to both shooters and dealers. Gun shows and shooting events are also frequented by dealers as well as by other commercial reloaders, most of whom don't cast their own bullet inventories. These are good places to make contacts with the dealers and a good place to find out what your competitors (if there are any) are doing.

Individual shooters who shoot in organized competition use a great many bullets. Package your bullets in boxes or bags of a thousand, and offer a discount for bulk purchases. Bulk sales are less expensive for you, and they increase your sales.

One last note about selling at gun shows and shooting events: if you have developed a dealer network, and your dealer customers are also at the same events where you are, and all of you are trying to sell your products, you will find that they will not appreciate your competing with them. If you must sell your products at the same events as your dealer customers, be sure that you are selling them for the same price that they do at their store. If you don't, you may very well lose a lot of good customers.

Another group of potentially high-volume customers are law-enforcement agencies. Many of these cast their own bullets, but many more purchase them — and many agencies that cast their own might be eager to find a dependable, economical source of good bullets so they won't have to go on making them. The larger police departments shoot more, generally, but don't ignore the smaller departments. The largest departments frequently purchase commercially reloaded ammunition. If one you contact purchases reloads, try to find out who their supplier is — you may be able to sell him bullets for his reloading operation, and he will use many of them.

If you use the numerous shooting-products distributors as your major outlets, you can expect to have to produce bullets in great volume — but as before, the margins will be considerably less. Consider this for a moment: you must make a profit, and the distributor must make a profit, and the dealer must make a profit. If the selling price at the dealer's level remains constant because of competition, then you have to reduce your price to accommodate these different levels of profit taking.

But distributors purchase bullets by the millions, and supplying them would mean an enormous increase in volume for any commercial bullet caster. Remember, however, that distributors can and do wait sometimes as long as six months before paying for what they have purchased. Be certain that you are able to stand the financial strain before you enter into any agreement with a large-volume distributor.

It is not unusual for a distributor to agree to send you full payment in ninety days, but then actually wait a hundred eighty days before sending you your money. If you're not prepared to wait a long time for your money, you should stay clear of distributors.

### *Advertising*

Whether you are selling your products to dealers or directly to individual shooters, it pays to advertise. You will be astonished at just how expensive advertising is, especially in the periodicals with a large circulation. If you advertise, you absolutely have to advertise in magazines whose readers are going to purchase your products. An obvious magazine not to advertise in would be *Ladies Home Journal*. You can imagine how many sales you will get — if any at all — from the readers of this magazine.

It is beyond the scope of this chapter to tell you just which periodicals are the best for your products. Magazines come and go, their readers change their interests, and sometimes magazines even change their natures. Research is the answer. Get a copy of every magazine that seems to cover the interests of reloaders.

Or if you are primarily interested in dealers, you will find, with a little research, dealer-oriented publications that restrict their circulation to commercial dealers. Write to the advertising director of all the periodicals that interest you and ask each of them for their media kit. They will send you a folder containing a recent copy of their periodical, some statistics about their readers, and a rate card showing the costs of advertising in their magazine.

If you elect to advertise in a periodical, try to prepare your own ad material. The magazine will help you and charge you a small fee to make your material camera-ready. If you book the ad yourself, tell the advertising director that you are an in-house agency, and you may deduct fifteen percent of the cost of the ad. This may not seem like much, but over the course of a year, it can really add up.

Study the ads in the magazine, and you should be able to develop your own.

Before we go much further in our discussion of ads, it is a good idea to let you know what you can expect from an ad agency if you decide to use an agency to promote your products. First, ad agencies earn their income by taking fifteen percent or more of everything you spend. For instance, if you place an ad that costs a thousand dollars, the periodical will rebate the ad agency a hundred fifty dollars. This is normal, and that's the way it's done.

Also, if you need photographs of your bullets to make up the body of your ad, the agency will hire a photographer to take the photos, and the fee you will pay for this service will be fifteen percent more than the photographer charged the ad agency.

As you can easily deduce, it is directly in the interest of the agency for you to spend as much as they can persuade you to spend. Obviously, fifteen percent of a big advertising budget is much more than fifteen percent of a little one. And fifteen percent of nothing is nothing. The more you spend on the advertising they handle for you, the more they make. Unfortunately, if an agency is more interested in making money than in being certain that you are going to get the best possible publicity for your products, you are very likely to waste a lot of money for very little return.

Finding an agency that will do an excellent job for a minimum amount is the hard part.

### *News Releases*

One technique that is extremely productive and largely ignored by the small manufacturer is the news release. A news release brings in about the same number of responses as an advertisement, and the cost is vastly less. In fact, the magazine prints them free as a service to their readers — also in the hope that if the release pulls well for you, you will advertise in their periodical. The only actual cost incurred in a news release is the cost of a black-and-white photograph, a sheet of typing paper, an envelope, and postage. This is not much, considering the cost of an ad.

To make matters even more exciting, send a news release to every outdoors magazine that covers your product, editorially and with advertising, place a key phrase in the address (like *Dept GA* for *Guns & Ammo*), then count the responses that come in as a result of that periodical's use of your release. The one with the most responses is the one where you will get the best results if you place an ad. This is the only way to know for certain just which periodical will do you the most good. Of course, if you have a lot of spare cash, you can always advertise in all of them and not worry about it.

The news release itself should be no longer than about a hundred words. Keep it brief and to the point. Always include a *good-quality* black-and-white photograph, a 5x7 or better yet an 8x10. The important key word here is *good-quality*. If you have a good 35mm camera and know the difference between good and not-so-good black-and-white photographs, you can take the photos yourself. But don't kid yourself — if you are not a good photographer, have someone else do it who is good. If you don't know anyone whose work is good enough, hire a professional. It will be well worth the small expense.

After all, it is your intention to become a professional businessman. What you have printed in a magazine will have a profound effect on just how professional you appear. Almost every monthly periodical has a "What's New" column or page. Read them, study them, then make yours more or less like them.

Every time you introduce a new bullet or bullet weight, send out more news releases. Even if only a few get publishied, it will be well worth the expense. If you are selling directly to the consumer, send these releases to the publications that consumers read. If you are selling to dealers, send your releases to the publications that dealers read. You will find with a little research four to six periodicals (perhaps more) that service their interests.

## *Working with Writers*

If a professional outdoor writer reviews your bullets and gives them a good write-up, even his brief mention can give your bullets an enormous amount of publicity. Everyone is so accustomed to advertising as "the" way to promote products, that most people simply pay no attention to ads. But if they read about something in an article or column, they assume that what they have read is fact. Start paying attention to the writers who cover reloading and bullet casting in their material. Write a letter to them in care of the publisher and tell them that you would like them to try out your bullets, no strings attached.

If a writer is interested in trying your bullets, he will write or call you to request some samples for testing and evaluation. Send him all that he wants, within reason — and several months later, you may very well find your products mentioned in his column. Also, you may make some very nice friends.

It should go without saying that you should be careful about the samples you send him. Make certain that they are good bullets. It is amazing just how many people leave this little chore to someone else, and the samples that get sent are rejects intended to be remelted. If the writer is kind, he will contact you and let you know of the problem, and you can correct it. If he is in a hurry, he may write that you produce a pretty lousy product. You can imagine what that will do for your sales.

And just as it makes sense to check first to see which magazines are most likely to present your ads to the best market, so also does it make sense to read a good number of the articles and columns by writers who regularly publish material on shooting and handloading. You're in double luck if the best magazine for your advertising also has the best handloading writer on its staff. In any event, you want your bullets tested by the best handloading writers, not so much by the shotgun writers who may never take your bullets out of the packages you send them.

If you get requests from writers you've never heard of, don't be eager to send out boxes of sample bullets too freely. Unfortunately, many part-time and would-be writers can (without meaning to do anything unethical) soak up large quantities of free bullets without any word getting into print where their mention of your bullets would do you any good.

It's a good idea to designate or set aside a certain number of bullets to be used for publicity, then — if you get a few writers' requests for bullets after this supply has been promised or sent out — you can reply that your publicity supply has run out, or you can decide which if any of those requests are worth special consideration. Use your judgment. Don't be either stingy or wasteful with your samples when writers want to try them — but remember that at your costs, a few bullets don't cost much, so it's better to be almost wasteful than to be almost stingy.

Remember that even one or two writers' evaluations can help you immensely, but don't expect any mention of your bullets in a magazine article to make you rich and famous overnight.

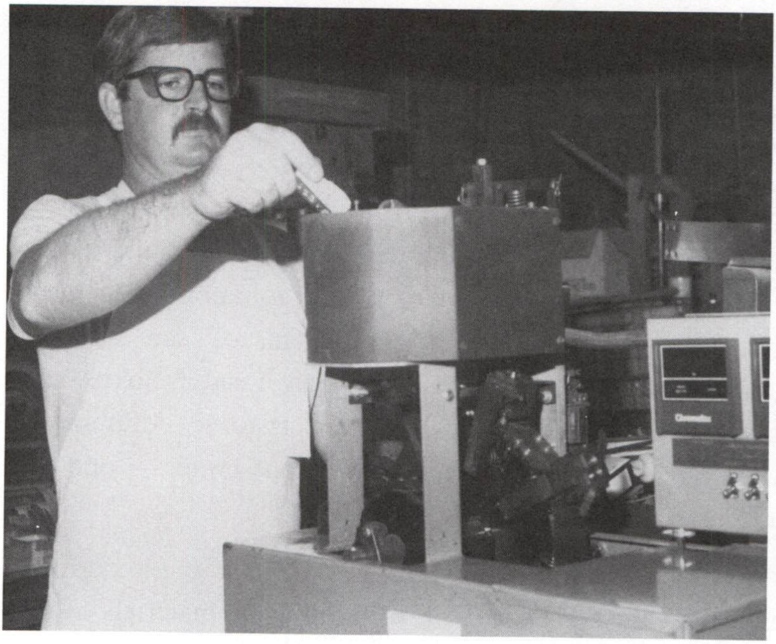
All effective product promotion takes time. You can't expect to see substantial results in only a couple of weeks. Take your time and do it right — your long-term potential can be very impressive.

# *Safety and Hazards*

CASTING BULLETS commercially can be quite safe if you take a few basic and mostly common-sense measures. Virtually all the major components of lead alloys — including lead itself — are hazardous. Lead is toxic, antimony is toxic, and obviously arsenic is toxic. Antimony is every bit as toxic as arsenic. Tin is not toxic — one that isn't, among many that are.

Besides the well known hazards of handling toxic materials, there is the hazard of working with materials whose normal operating temperature falls somewhere between seven hundred and eight hundred degrees Fahrenheit. When molten lead splashes onto clothing, it sticks there and continues to burn, and it doesn't notice the differences between clothing and bare flesh.

Anyone who has suffered this experience can tell you that it is most unpleasant. Some bullet casters can tell you that you haven't lived until you've had a puddle of recently molten bullet metal "cool" inside your shoe, right under your instep, while you invent wild and vigorous new dance steps. It seems to have a natural affinity for hard-to-enter places like the slit between ankle and shoe leather. You must always take the utmost care when you're handling molten lead alloy. It burns without regard to race, color, or religion, if any, and no matter whether you swear or pray. It does not discriminate in the slightest. Just let it touch you, and it will



*Always wear safety clothing (at the least, good eye protection, heavy gloves, and an apron) whenever you cast bullets or add bullet metal to your melting pot.*

burn you badly. Keep water or moisture as far away from molten lead as is practically possible. Be absolutely certain that any scrap lead you drop into a pot of molten lead has absolutely no water, ice, or snow on it, in it, or around it.

The least you can expect is a violent spattering. The most, a violent explosion that will empty your pot of all molten material and spray it everywhere. If this probably large quantity of molten lead splashes on you, you can expect severe burns, possibly blindness, or in an extreme case even death. If you are hand casting, always inspect your ladle or dipper for moisture that may accumulate there, before you insert the dipper into a pot of molten lead. Always preheat your ladle or dipper before you plunge it into molten lead — by floating your dipper on top of the molten lead. This will allow any built-up moisture to evaporate before it can create a dangerous situation.

The same precaution applies to ingot molds. Always inspect your ingot molds before you pour lead into them. Water in an ingot mold can cause a truly violent reaction. Store your ingot molds upside-down in a dry place. But remember, water can condense in molds of any kind, and any amount of moisture there can be the cause of a potentially dangerous situation. If you also reload, keep all powder and primers, including spent ones, away from your casting area. Just one live primer in your molten lead can make your life more exciting then you ever thought anything could. Painfully exciting.

Always wear safety glasses whenever you are around molten lead. One moment of forgetfulness can easily result in molten lead splashed in your face. Glasses can and do save eyes.

An apron (plastic, leather, or rubber) can prevent molten lead from sticking to your clothing. Wear it, and you will not only save yourself burns — you will also make your wife eternally grateful. Always pay close attention to your melt temperature — and never, if you can avoid it, allow the temperature to approach nine hundred degrees Fahrenheit. At nine hundred degrees Fahrenheit, lead begins to fume profusely. Its fumes are invisible, colorless, and odorless.

You will never know what is happening, but be assured that it is happening. The fumes are toxic, and at nine hundred degrees, you are greatly increasing your danger of lead poisoning. In addition, always cast or melt in a well ventilated area. Lead fumes accumulate in enclosed areas and greatly increase your exposure to lead poisoning.

Even more hazardous than the risk of lead poisoning from fumes is the real danger of lead poisoning from drosses. Drosses are everything from the lumpy liquates that you skim off the top of your molten metal to the fine dust that forms on the top of your metal. Lead oxides (another form of dross), or if you will, lead "rust," can easily form on scrap lead materials when they are at room temperature. Keep your work area clean, and whenever you handle scrap materials, be certain that you completely wash up.

Keep all drosses in the same container with a sealable lid. If you do your raw-material research well, you should be able to find a lead foundry in your area that has a smelter. A smelter is any foundry that has a blast furnace, a reverb furnace, or a rotary kiln that can reach temperatures high enough to smelt drosses. This is by far the best way to dispose of your waste materials. These plants at the very least take these materials off your hands.

If your volume is high enough, they actually purchase these materials. However, don't expect them to get excited unless you have somewhere between five tons and a truck load. Store the dross materials in 55- gallon drums with tops on them — keep them out of the rain and standing water. Certain contaminants, like calcium, when captured in drosses and contaminated with water, release stibine or arsine gas.

These gasses are highly poisonous, so take extra care when you store these materials. A single 55-gallon drum can hold approximately fifteen hundred pounds of dross, so it is necessary to accumulate many of them before you have enough to interest a foundry. It is also a good idea to consider how you're going to move containers that weigh more than half a ton apiece.

The Environmental Protection Agency has classified all drosses as hazardous wastes, so legally you have only two alternatives. The first is to dispose of the drosses at a hazardous-waste landfill site at great expense. The other is to sell the drosses or even give them away to a commercial foundry where they are classified as raw material.

This is really no contest. In the first case, these drosses are an expense, and a large one at that. In the second case, they are an income-producing asset. If you elect to just throw these drosses away or dump them at a sanitary landfill (the local dump), you will be violating a host of federal, state, and local laws. If you get caught, you can face very stiff fines and prison time and be forced to clean up everything that you have disposed of. Not a very pleasant thought.

Find a foundry that can process your waste, and you will be free from all worry and liability, and get paid for it as well.

The same foundries also use all drosses that you have created using fluxes such as sodium hydroxide. It is even possible to enter an arrangement where they trade you specification alloy for your drosses.

When you use sodium hydroxide, do not forget that this chemical is very corrosive. It is every bit as corrosive as sulfuric acid. Avoid contact with it always. If you touch it or somehow get it on your skin, wash the area immediately. Wear your apron always. Sodium hydroxide will burn holes in your clothing just as fast as a strong acid will. Do not under any circumstance get sodium hydroxide in your eyes. It can blind you. If you get it in your eyes, flush your eyes with water immediately and profusely. Seek medical attention immediately.

Sodium hydroxide also has another property that can cause considerable hazard. It is hydroscopic. This means that it absorbs moisture (water) directly from the surrounding air. Always keep sodium hydroxide in its original container and keep it sealed except for the brief time you are using it. Never plunge the pellets or crystals beneath the surface of molten lead. If you do, you will not only experience an unpleasant explosion — you will also have molten lead splattered on you, lead coated with the extremely corrosive sodium hydroxide. Extremely unpleasant.

Always spread sodium hydroxide on the surface of molten alloy and let it melt, thus evaporating all moisture that it may have absorbed. Be patient — waiting too long causes no problem, whereas not waiting long enough is extremely hazardous. When the sodium hydroxide has thoroughly melted, then and only then stir it into the metal. Remember, the resulting dross that you skim from the metal is just as corrosive as the original sodium hydroxide. Do not touch it, and if you do, immediately wash yourself well, wherever you have contacted it.

These last few precautions are obvious, and I include them here only because each one has indeed been violated by someone who lost his concentration and allowed his mind to wander.

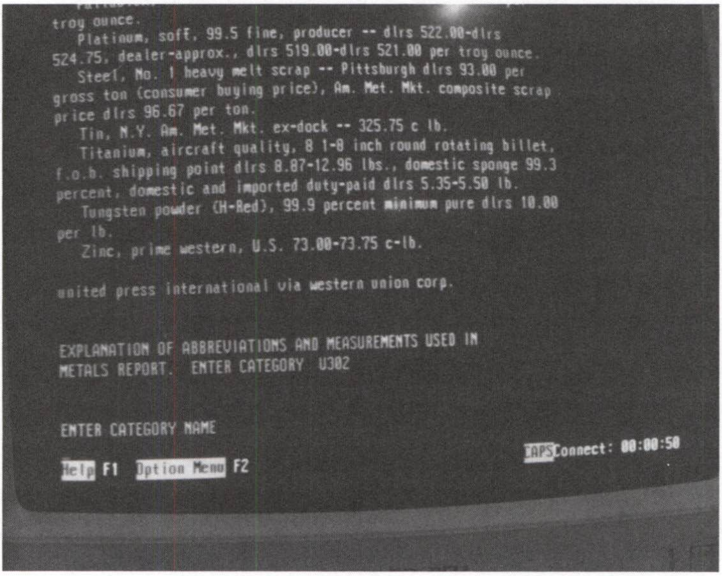
Never insert your hands or a tool into an automatic casting machine while it is running. This can cause a serious or even crippling injury.

Lead is heavy. If you handle heavy pieces of scrap or heavy ingots, be careful. Dropping a heavy piece of lead on your person will not do you the slightest good. In addition, use good lifting posture. Bend your knees and lift with your legs, not your back. This technique helps avoid back injury.

If you package your bullets in large quantities, the packages will be quite heavy. Use care when you lift them. Clean your casting area every day. When you sweep up, try not to stir up a cloud of dust. This dust can spread throughout the house or other areas, and it can contaminate everything and everyone.

Children are much more susceptible to lead poisoning than adults. The work area is much easier to keep clean if you do it daily. Dust clouds are more easily avoided if you don't allow the dust to accumulate in the first place and clean the area with a vacuum cleaner instead of a broom. If you use a vacuum cleaner, dedicate it to the work area. Place all the dust you recover from the cleaner in the same barrel with the other drosses. And last, if you purchase scrap in sheets (like sheet lead) or other forms too large to melt directly into your pot, do not cut them up with any form of torch. High-temperature cutting torches greatly exceed the dangerous nine-hundred-degree fuming temperature of lead, and you will greatly increase your risk of lead poisoning. Use a saw instead. You can easily cut any lead alloy with almost any saw, and the resulting metallic chips (they're not drosses) are much easier to clean up.

Commercially casting bullets can be a safe and rewarding enterprise if you follow these simple recommendations. Most of them are common sense. If you don't follow them, you're begging for trouble — and will soon get what you're asking for.




*In addition to its many other business uses, a personal computer with a modem can give you telephone-line access to the current prices listed on the metals market.*

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# Odds and Ends

IT SEEMS THAT every book must include one chapter dedicated to those bits of information that can't be left out but don't warrant separate chapters all to themselves. So it is with this handbook.

## *Hardness Tester*

Lead Bullet Technology in Moyie Springs, Idaho, produces a Brinell hardness tester that can be very useful to the commercial bullet caster who has no access to a laboratory. The small and economically priced device tests the hardness of any but the softest alloys. Presumably, if you keep the weight and hardness of an alloy the same from batch to batch, you could use this information as an informal test for quality control. Considering its price, the LBT hardness tester would be a good device for the commercial bullet caster to have on hand. Complete instructions come packaged with the device.

## *Laboratory Services*

Sooner or later, every commercial bullet caster is going to encounter a problem using secondary materials. When one of these problems occurs, it is a good idea to have a commercial analytical laboratory available to submit samples to, for assay. Every major city has such laboratories. Contact them for information on their procedures and pricing. Find out whether they charge for each element they test for or have a simple fee for a complete analysis. If they charge for each element, request an assay for antimony, tin, arsenic, copper, aluminum, and zinc. They always report lead as the balance, and the above elements account for the vast majority of problems, particularly aluminum and zinc. The others are useful to know for alloying.

If things go wrong, try to identify whether the problem stems from the alloy or is a mechanical difficulty. If you receive a complaint from a customer that your bullets simply don't shoot well in his gun, the most likely problem is his gun or his load if you have not received many similar complaints. How far you go in aiding a disgruntled shooter is up to you.

It is simply not economically feasible to cast bullets for every possible bore diameter for every gun in all calibers. If the problem appears to be in the metal, send a sample to a laboratory for evaluation, if you have large quantities on hand. If you have small quantities on hand, dilute it down with other metals until it no longer causes a problem.

## *Factory Services*

If the problem appears to be with the casting machine, first consult the instructions that came with your machine, to see whether you have assembled everything properly. If you still can not resolve the problem, call or write the manufacturer, and they will assist you. When you purchase any machinery, be certain that the manufacturer provides customer support in the form of spare parts and telephone support. This is essential for your economic growth and the stability of your business. Its importance can not be overstated. This is the primary reason the Bullet Master and Master Caster were used as the primary focus in this book. It will do no one any good to have a machine that can not be repaired or one for which parts are not available when you need them.

## *Bullet Casters' Myths*

If you continue to gain knowledge of bullet casting, you will undoubtedly read sooner or later a number of things about alloys, molds, casting. *etc*, that simply are not true. For example, many bullet casters believe that the composition of scrap wheel weights is nine percent antimony and the rest lead. Wheel weights are three percent antimony and the rest lead, with insignificant quantities of residual elements. I've seen hundreds of assays of hundreds of tons of scrap wheel weights over more than twenty years, but I have never seen even one wheel-weight alloy whose antimony content even approached nine percent.

Another favorite myth is that gravity will separate the tin out of a molten lead alloy if you let it stand long enough. Not true. The commercial procedure for removing tin from lead alloys is to heat the metal up to twelve hundred degrees Fahrenheit and stir it rapidly for at least three hours. This procedure removes the tin in the form of a very bright yellow dross and is far beyond the capabilities of most commercial bullet casters' equipment.

Even if you can heat your alloy to twelve hundred degrees Fahrenheit, you shouldn't even think of doing it. That's three hundred degrees beyond the red line of danger to your health and your life. In addition, tin is an element that a commercial bullet caster would rarely want to remove.

If a situation happens to occur where the tin content is too high, it is preferable to dilute it to the desired concentration with soft lead. To make matters even more interesting, the iron pots in use (not to mention the heating elements) weaken considerably at such high temperatures. Even in the commercial lead business, their iron pots frequently burn through and discharge the entire contents of the pot down into the setting. It is quite a mess, dangerous, and quite costly. Don't risk it.

Another bit of myth you may encounter is that of someone writing about the reclamation of range lead. If anyone gives you the composition of range lead without having it analyzed, the figures are wrong. The composition of range lead changes every time another batch is analyzed. If everyone fired the same bullet, then there would be a chance that the analysis would be more or less consistent. Since this rarely or never occurs, the analysis is certain to vary. Count on it. Incidentally, range lead is a fair source of raw material, but don't count on the analysis.

## *High-Tech Communication*

It may have occurred to you, as you read the chapter on how metals companies determine the base rate for their alloys, that you could do the same thing if you had the same access to the daily metals-market reports as they do. In fact, there are several options you might want to look into. The first is to subscribe to *The American Metals Market*. This daily newspaper covers the latest developments in all metals, news, markets, and so forth. Unfortunately, it is quite expensive, and you don't need it unless your volume is so great that you are buying metal almost daily.

The second option, and the most economical, is to pick up a copy of *The Wall Street Journal* whenever you need current market data. The same information that is in *The*

*American Metals Market* is also printed in *The Wall Street Journal*; however, the two papers' reports don't always agree. The difference is always slight, however.

A third option, and one that also allows access to a host of additional information, is to use a microcomputer like an IBM XT (or higher) clone. With one of these units equipped with a modem, you can contact the metals market directly for up-to-the-minute market updates. If you subscribe to EasyLink, a service provided by Western Union, you can — in addition to contacting the metals market directly — send a fax message or document to any fax machine in the world, and send and receive telex messages to any telex machine in the world. You can do all this at considerably less cost than by going to the local Western Union office and having them do it for you.

As an example, you can send a half-page fax message anywhere in the United States for about fifty-five cents. Not bad when you consider how much a telephone call costs. If you need information about installing Easylink on your computer, call Western Union at 1-800-HELP-ESL. They can answer all your questions and send you the applications you need for a hook-up. They can also supply the software (for a very modest cost) that makes the link-up quite easy.

Of course, any communications software will do the job, too, including the public-domain and share-ware programs that you can get by mail order (through ads in computer magazines) for just a few dollars — or for nothing from a computer bulletin-board service.

Besides the above, Easylink provides a host of other services that range from current currency-exchange rates to translating letters into any language for you. In fact, Western Union has included so many services in their basic package, I'd have to write another book just to explain them all in detail. Couple this service with a word processor for your computer, and you will have a communications system that is the latest state of the art.

In fact, you can contact Magma Engineering and most lead manufacturers through the same service, and the communication is practically instantaneous.

I hope these chapters have been of value to you in your commercial bullet-casting enterprise. If you follow the procedures I've outlined in this handbook, you will avoid ninety-nine percent of the problems that plague beginning commercial bullet casters.

Good luck!

# Appendix

## Sources of Equipment, Services, and Supplies

- ***Bullet-Casting Machines & Parts***

    Magma Engineering Company
    P O Box 161
    Queen Creek, AZ 85242
    (602) 969-3122

- ***Bullet Molds***

    Magma Engineering Company
    P O Box 161
    Queen Creek, AZ 85242
    (602) 969-3122

    NEI/Tooldyne, Inc
    9330 NE Halsey Street
    Portland, OR 97220
    (503) 255-3750

    RCBS
    605 Oro Dam Blvd
    Oroville, CA 95965
    (800) 533-5000

    Lyman Products Corporation
    Route 147
    Middlefield, CT 06455
    (203) 349-3421

Redding Reloading Equipment
(SAECO molds)
1089 Starr Road
Cortland, NY 13045
(607) 753-3331

Lead Bullet Technology
HCR 62, Box 145
Moyie Springs, ID 83845
(208) 267-3588

## • *Specification Bullet Alloys*

Taracorp Industries
16th & Cleveland
Granite City, IL 60240
(800) 851-3300

Magma Engineering Company
P O Box 161
Queen Creek, AZ 85242
(602) 969-3122

Tejas Resource - Texas
(214) 563-1220

RSR - Los Angeles
(818) 330-2294

RSR - Dallas
(214) 631-6070

NSM Co. - Hunington Beach, CA
(714) 892-3511
(714) 897-8490

Metal Merchants - Detroit Michigan
(800) 876-5337

Evans Metals - Atlanta, GA
(800) 241-4590

Liberty Metals - Los Angeles, CA
(213) 581-9171

Essex Metals - New Jersey
(800) 282-8369

Federated-Fry - Altoona, PA
(800) 289-3797

Ames Metal Co. - Chicago, IL
(312) 523-3230

GNB - Frisco, TX
(214) 377-2121

GNB - Columbus, GA
(404) 689-1701

Art Green - Beverly Hills, CA
(213) 274-1283

Phoenix Metals - PA
(412) 287-4611

Peerless Metals - Denver, CO
(303) 825-6394

TCSR - White Bear Lake, MN
(800) 328-6394

## • *Bullet Lubricants*

Magma Engineering, Company
P O Box 161
Queen Creek, AZ 85242
(602) 969-3122

RCBS
605 Oro Dam Blvd
Oroville, CA 95965
(800) 533-5000

Lead Bullet Technology
HCR 62, Box 145
Moyie Springs, ID 83845
(208) 267-3588

Lyman Products Corporation
Route 147
Middlefield, CT 06455
(203) 349-3421

Redding Reloading Equipment
1089 Starr Road
Cortland, NY 13045
(607) 753-3331

## • *Bullet Hardness Tester*

Lead Bullet Technology
HCR 62, Box 145
Moyie Springs, ID  83845
(208) 267-3588

## • *Recommended Reading*

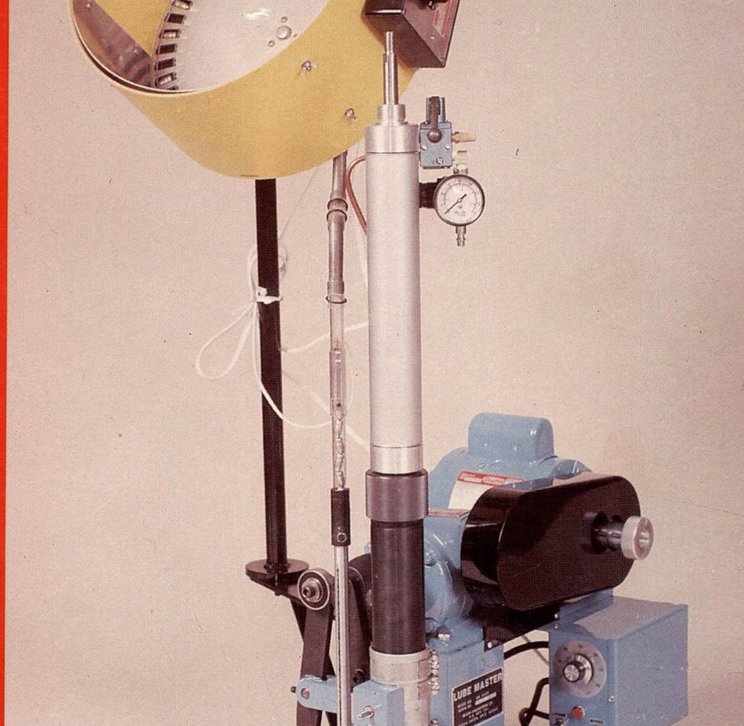
E H Harrison, *Cast Bullets*
NRA Book Service
1600 Rhode Island Avenue, NW
Washington, DC 20036

C Kenneth Ramage, Editor, *Cast Bullet Handbook*
Lyman Products Corporation
Route 147
Middlefield, CT  06455

Wilhelm Hofman, *Lead and Lead Alloys*

## • *Computer Software*

Not available yet — but soon to be published — is a computer diskette for IBM PCs and compatible microcomputers, which will contain all the formulas in this handbook, for making up alloys, determining yields, and analyzing costs. The programs that will be on this diskette are very easy to use. With their help, any commercial bullet caster with access to a suitable computer can simply type in the numbers when the programs ask for them, and the programs will answer all relevant questions.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