Power Swaging

Corbin Technical Bulletins,
Volume IV

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Introduction

Power swaging, in the context of this book, is the production of bullets (the projectile portion of a cartridge, not the loaded round itself) using precision dies operated at room temperature under extremely high pressures. In custom bullet making, the pressure is generated by means of a hydraulic powered press, controlled by electronic sensors and logic circuits, applied through a tough, precisely-fitted punch in one or both ends of the die cavity.

The press pushes a moving ram, which generally holds the die (unlike reloading presses, where the die is held fixed in the press head). The internal punch travels inside the die along with the ram, and is used to eject the bullet as well as to seal one end of the die. The external punch is held fixed in the press head but is adjustable for maximum insertion by means of its threaded floating punch holder.

Swaging itself, whether by hand or power, offers high precision, speed, and safety plus a degree of versatility known to few other bullet-making processes. A vast array of bullet styles can be made with one rather simple set of tools. Changing calibers (taken to mean diameter of bullet, here) requires a new die, but within one diameter of bullet, you can make almost any style, weight, or shape with changes in technique, or modest additions to the basic tooling set.

Since no molten lead is used in swaging, safety is greater than with cast lead production. Swaging operations can be run from small spaces, without the need for as much ventilation and no fire insurance worries. A major bullet business can be developed in one's garage or workshop (many have been, already). Versatility, speed, safety, and precision all give swaging a considerable advantage over other means of making bullets.

Power swaging adds three factors that you cannot achieve, at least not as easily or well, with hand powered presses:

(1) Power systems can develop higher pressures than hand press, using larger dies and punches, and can generate these pressure levels under extremely precise control at all times, which permits tooling designs impractical with hand systems. Full power is applied from the start of the stroke, not developed only near the end as with compound leverage presses, making longer draws and extrusions possible.

(2) Power systems are tireless and can be operated constantly, around the clock if need be, without any change in the quality of the product. An honest hand-press operator will admit that it is difficult to maintain consistent, long runs because the muscles tire and one's sense of feel becomes dull with hours of repeated labor.

(3) Power systems can be built with the skills of an experienced bullet-maker designed into their logic and sensing circuits, making it possible for virtually unskilled labor to produce as good a bullet, consistently, as the system designer.

Greater power, tireless operation, and built-in expertise all combine to give the owners of power swaging presses the ability to "clone" their efforts: if they develop a good design and find the market greater than one person alone can handle, they can purchase another press and set just about anyone to work making the bullets. The quality is both in the designer's ability to make something good, and the ability of the press to give repeatable accuracy without any particular level of skill required from the operator.

A major difference between this kind of "smart" press, and simply hooking a hydraulic cylinder to the end of a manual press, is the built-in sensing of pressures, speed, position, and timing. Good quality comes from consistently applied stroke, speed, pressure, and timing. None of these can be achieved with an ordinary hydraulic cylinder / pump arrangement attached to a manual press.

There is no method of feedback and control in a simple slam-bang press. One cannot expect to use log-splitter hydraulics and work with tooling that is designed to hold tolerances in the range of 0.0001 inches at pressures that can exceed two thousand atmospheres! The materials require time to flow. They do not instantly take on the shape of the die. It may seem that way, and we may even talk about instant forming of the parts. But in reality, most of the operations require milliseconds of approaching the maximum pressure, to allow the material to start to move, and to finish flowing completely.

Dies can be blown apart with exactly the same pressure and material that works well with a slower ram speed. The difference can be virtually undetectable to a person with a stopwatch. Only the precision of electronic timing can catch the milliseconds of difference that sometimes spell tragic failure (as in replacing a cracked die) or excellent production rate. The press design needs to include precision speed, pressure and dwell timing controls.

The special presses described in this book incorporate years of painstaking research and development, thousands of computer simulations, tens of thousands of dollars worth of experiments that pushed the limits of what could be done and uncovered what worked, and what did not.

It would be an error, at best, to assume that the same results could be achieved just by using more force. The point of this book is not just the use of more force, but of correctly controlled force. The correct operation may, in some instances, require greater force than could be developed with any practical hand press, but in other cases it may be well below the limits of pressure you could develop with even the smallest hand press.

In either case, it is not just how much pressure or force that is important, but how it is applied. The length and precision of dwell time, the methods of support for the punches and dies, the materials used to apply the forces and their resistance to change over a period of time, the repeatability of the pressures from one bullet to the next, and the method of controlling stroke positioning and length, all affect the quality of bullet you can produce.

Rather than hiding the tremendous wealth of knowledge that has been built through years of constant research, I would like to share it with you. In the short run, it would probably be wiser and certainly more profitable to keep quiet and simply use it ourselves to make world-class bullets. Dies last nearly forever with proper care; bullets are made to be used up with one shot. The repeat sales potential speaks for itself!

But in the long run, it is better for everyone if you know how to produce exotic bullets from common materials, how to turn copper and brass and lead (not to mention dozens of other materials) into advanced bullet designs. These concepts have been used to make bullets so advanced that hundreds of new enterprises are already providing shooters with a selection of bullet performances never before possible, and major bullet factories are loudly proclaiming the “invention” of such novel ideas as bonded cores, which our clients have been making for decades.

It is already starting to be “in the long run”, since my clients have been introducing new bullet concepts built on our swaging systems for over four plus decades. There are hundreds of individuals, who probably have interests and abilities little different from your own, now using our power swaging equipment to produce custom bullets of remarkable performance, whose names you see every time you open a gun magazine. This is in addition to over ten thousand shooters who build their own swaged bullets with our hand-powered presses and dies. Security, an enjoyable career (or second career, in many cases), and the pleasure of being the best in a demanding field are the rewards these individuals reap.

This is being recognized more and more often in the firearms press. Major articles appear periodically in popular magazines verifying in excited tones that, yes, there really is another world beyond mass produced or cast bullets, and it's populated with highly successful bullet-makers, with backlogs of orders in nearly every caliber and style imaginable!

People actually make a living producing custom bullets? Absolutely! It's not uncommon for someone to quit a "regular" job, and just stay home to make bullets after the first year or two of playing with it. Many people do this with hand presses. But they usually do not make as much money, nor as quickly, as they could with a power system.

The reason is that most of the bullets which demand a high price today (and are worth it, when you need the performance) are those having features that are more difficult, sometimes impossible, to produce on a hand press. You can go a long way toward that kind of performance but you can't step over the magic boundary into the really high profit realm without using power.

Power presses are owned by fewer bullet makers than hand presses because (surprise!) fewer people can afford them. Naturally, this gives you an advantage because you can focus on bullet designs that would be too difficult, slow, or even impossible to build with a hand press (as well as making the same designs that compete with hand presses, but with more precise control).

You are not buying production speed so much as design ability. Speed is not the most important issue. The major mass producers of bullets have invested hundreds of thousands of dollars in transfer, eyelet, or mechanical punch presses with progressive die sets that can stamp out an average of 40 bullets a minute, 2400 bullets an hour, 19,200 bullets a day, 5.76 million bullets a year. These bullets sell for five cents to fifteen cents each, because they can be marketed to the average shooter who only wants to pay the average rate for an average bullet.

Those high-speed presses do not approach the kind of exotic bullet designs that you can make at home with a programmable power press costing a fraction as much. And consequently, you can make bullets that will sell for fifty cents to two dollars each, to a much smaller group of buyers who know what they want and are willing to pay for it.

The less automated a press is, the more flexible it can become. And the faster you try to make it with automatic handling equipment, the more it becomes locked into making just one caliber, one weight, one length, one shape of bullet. The process can become a snare: the faster you go, the more equipment costs; the more it costs, the more you have to sell to break even; to sell more, you have to keep the audience big and thus the price small; the lower the price, the faster you have to make them to show any profit... see what I mean?

If that begins to sound more and more like something you'd enjoy less and less, then consider an alternative that pays as well by taking a different direction....

Instead of buying expensive, inflexible high speed equipment that must compete for volume with other firms already established on a price basis, use relatively inexpensive, versatile low speed equipment that produces exactly what the top end of the market demands and puts you far beyond competition with existing mass-market firms. It's an idea to think about. Is it better to sell a million things for a penny each, or one thing for a million pennies? You might work harder finding the market, but once it has been located, the latter method certainly offers less continual effort and expense. It's more fun.

One of the saddest facts I've learned about life is that most people don't have fun with the main thing they do, the thing that gives them their sense of place in society: their work. Right or wrong, it seems that in most situations you are what you do for a living. Shouldn't it be at least as enjoyable as the few days a year you are doing something else?

I always thought so, and arranged my life to do things that were fun and still made a living... such as, helping hundreds of people to break free from boring jobs and become independent bullet makers. With some people, it is easy to point out the obvious advantages and show the way to reaching that goal. With a few, it is a major struggle just to get them to look at anything but high volume manufacturing and the required low profit per bullet that enables it. So I need to dwell just a bit longer on the production treadmill....

The problem with excessive speed is that (1) it costs far more than it is worth in a custom market and (2) why bother, when you'd only saturate your own small quantity of buyers with goods, force your price lower to survive, and wind up making less and working more for it! Why work for the bank, in other words, when you can have a versatile hydraulic system working for you instead, and just add workers and more presses if your bullets sell so well that you can't keep up with the demand?

Adding a second and a third press is far safer, far more profitable, and gives you backup in case you have a breakdown. There is nothing so frightening as having all your money tied up in one dedicated, fast machine when the bank payment is overdue and there is, broken, a ten-dollar part you can't get for another two months! So much better, I would think, to have two or three slower machines, all of which cost a fraction of the price of a high speed automatic press, but which turn out the same combined volume. Then, if one has a problem, you are still operating at 66% of your production capability, not shut down and out of business!

The objection raised at this point by the "high volume, low price" mentalities is that of labor cost. In a poor third-world country, banks of manually-fed power machinery are as economical as buying low-labor massive automation, but otherwise, how can a person afford to hire an operator for every press? Wouldn't it make better sense to spend the quarter-million dollars on a fully automated machine, instead of buying four or five six thousand dollar machines and paying their operators?

Of course it would, if you stay with the low profit, high volume concept. If you have a market for several million bullets per year, by all means take on the bank as your partner in automation and eliminate most of the work force. But the whole point of custom bullet making is high profit, low volume: investing far less in capital items and making higher profit items that can pay for flexible labor.

With the boutique nature of designer bullets, your operating expenses are primarily material and labor costs, not servicing the equipment cost. That means if the market slows, you simply don't use as much material or labor, and your equipment has long been paid for. Your business is relatively recession-proof because the top end buyers who want your bullets and can afford them in good times are not usually affected much by the bad times. And your operation isn't tied to a constant fixed overhead. You might not have income in a poor market, but at least your overhead stops along with production. With the high volume, low margin business model, when the market hits a rough spot, you are still paying for the expensive machinery whether you can use it or not. And your major clients are by definition those who want low prices and large volumes, the very ones who will be hurt most by general economic downturns.

I like to plan for the best, so I know what to do if business takes off beyond my wildest dreams, but still, I like to have an alternative plan for the worst that could happen. It seems to me that the business model based on high quality buyers is less at risk even though it may be more limited in ultimate potential. If you are interested in maximum income potential and not bothered by the risk of competition in a crowded field that is price sensitive, then high speed, high volume production still makes sense. There are mass producers doing just fine in this area. Most of them are making cast bullets.

But power swaging in this book is referring to a whole new concept in bullet marketing, compared to the usual thinking in the cast bullet field. If you are a cast bullet manufacturer, you know what it means to compete on five cent bullets and contracts for millions of slugs, often with agencies who cannot afford to be loyal to quality and who base their decisions on budgets.

Speed and volume count, more than anything. Competition is fierce. Casting is such an old method that everyone thinks they can do it. Sometimes it seems as if everyone IS doing it! Customers tend to regard bullets as interchangeable among vendors and brands. Price is king. Profits are elusive. And you move a lot of lead around regardless of the bottom line.

Now, in your wildest dreams, can you imagine making elegant hand-crafted bullets like fine jewelry, sought after by clients who are not concerned by price but who only want top performance? Can you imagine what it is like to have people begging you to sell them what few bullets you have on hand, offering you a premium over your normal prices, because they have a big hunting trip coming up and they want your bullets above all else?

If that sounds unbelievable, then maybe you won't think the pages of custom bullet makers listed in the Corbin World Directory of Custom Bullet Makers are authentic. You might want to send one or two of them a request for a brochure, or order a few bullets from them, just to test the water a little. Or, study the custom bullet maker articles, ads, and product reports that have been printed in popular gun magazines over the past few decades by people who are already doing exactly what I'm talking about.

The key to success in custom bullet making is in developing product performance so far beyond the mass market bullets that price is no longer an issue. And the cost-effective key to this kind of bullet is usually found in a hydraulic swaging machine and its special tooling, not in punch presses, automatic lathes, or high speed methods of mass production.

My final argument on the volume versus quality controversy is simply this: develop your product so that it sells profitably when made on low volume, high quality machinery. Then, with far less risk and initial cost, you can decide whether you really need to "make them by the millions" for that market. Add the high speed machinery only when you have assured yourself that you have a good product, and a market, based on the higher priced, lower volume strategy, instead of basing your design on the need to make a certain volume per hour in order to meet a predetermined price.

With this approach, it is almost impossible to fail. With the conventional approach, only one or two businesses out of a hundred succeeds.

Design of Power Swaging Systems

Four power sources are practical for swaging, other than the strength of your arm: (1) Direct rotational electric power, (2) Inertial storage of rotational electric power, (3) Pneumatic pressure, and (4) Hydraulic pressure. The rest of this chapter is a discussion of the design considerations.

Direct Rotational Electric Power

Direct mechanical application of the torque from an electric motor's shaft can be used, through a system of gears or belts, for low power swaging systems. It is best suited for fully-automatic systems that would use small calibers (under .308-inch) and soft lead cores in thin jackets, or up to .357-inch bullets with soft lead and no jacket.

Building such a device usually means driving the ram of a press with a cam or eccentric bar, like a steam locomotive drive piston being turned by the wheels instead of the other way around. This lets the motor run constantly in one direction, avoids inertial stresses produced by stopping and reversing direction of gears, and produces a simple fixed stroke machine designed primarily for one bullet.

Practical size machines would use a motor of 1/2 to 1-1/2 horsepower, reducing the speed to gain torque by operating through gear trains or belts and sheaves. A ram speed of not over 2 inches per second is generally desirable. The reduction from a standard 1725 RPM single phase motor is a 28.75 to 1 ratio. The necessary ram force depends on caliber, material hardness, and shape of the die, but a 10,000 pound ram force is generally adequate for all lead bullets from .357 diameter down.

A drive wheel or gear with nominal circumference of 3.14 inches or diameter of two inches is just about as small as a wheel can be made and still wrap a practical size belt or accept the power from an adequate motor. So let's start with a motor shaft spinning a one inch radius (2-inch diameter) wheel (gear or sheave).

The two standard motor speeds are 3600 and 1725 RPM for single phase, 60-Hz. motors. The 1725 RPM motor will have greater torque for the same horsepower, since horsepower is simply torque times speed. That means our one inch radius wheel will be spinning at 1725 RPM. The circumference of the wheel is 3.14 inches. The number of inches of wheel that pass by a fixed spot in one second, then, is simply 3.14 inches times the velocity of 1725 complete turns per minute, divided by 60 (since there are 60 seconds in one minute).

This is 90.275 inches per second. That is the equivalent linear speed of the wheel, and it is much too fast for moving the swaging press ram. The inertial of the components would mean a very complex, powerful system of automatic handling would be required to get them in position and back out again before the ram struck, and the results would not be too good since the torque or thrust would be so small compared to the initial impact momentum. Lead needs time to flow.

Slowing the linear speed down without decreasing the horsepower would give us more torque, too. So let's turn a larger wheel, having more inches around its circumference. The ratio of the drive wheel circumference to the driven wheel will be the ratio of reduction in speed, since every inch of movement from the drive wheel transfers directly into an equal distance of movement on the circumference of the bigger wheel.

The distance that the ram must travel to swage a bullet has to be equal to the length of the bullet, plus a tiny amount of room for clearance so the bullet can fit easily in between the die opening and the ram, plus the amount of alignment distance required inside the die itself. Alignment distance must be at least the diameter of the bullet, and preferably twice that. This prevents galling and tipping of the precision punch that fits in the die behind the bullet. In a dedicated press that was designed only to make one kind of bullet, the stroke could be shortened so it came out according to this formula:

$$\text{Stroke} = 2C+1.1L$$

...where C = caliber and L = bullet length in inches.

With a typical .38 handgun bullet, the caliber is .3750 inches and the length is .70 inches. The stroke, by this minimum length formula, would be 1.484 inches. This means that on the output side of our system of wheels (gears, sheaves and belts), there will need to be a wheel with a pivot pin located 0.742 inches from the center of the shaft, and to this pin we shall attach a connecting rod to the bottom of our ram.

An alternative would be to make a cam by mounting the center of a wheel eccentric to the circumference, such that the difference between the lowest point and the highest point on the wheel relative to the shaft center was 1.484 inches. Either way achieves the same results. The cam requires a method of retracting the ram, such as a stout spring or a groove in the side of the wheel with a matching pin riding in it, the pin attached to the ram.

We know the stroke length and approximate desired speed of travel. At two inches per second, a ram moving 2.968 inches would make one complete stroke in 1.484 seconds (it must move up and back, total of 2.968 inches at a rate of 1 second for every two inches). This means the shaft turning the cam wheel must be rotating one complete turn in 1.484 seconds, since each turn is a complete stroke.

Now we know the rotational speed required for the driven wheel: it is 1 revolution per 1.484 seconds, which is the same as .67385445 turns per second, or 40.431 turns per minute. The reduction ratio from input to output of our wheel system must take the 1725 RPM of the motor down to 40.431 RPM for the cam wheel that drives the ram. This is a ratio of 1725 divided by 40.431, or 42.665 to 1.

If you think about it, you will see why mechanical rotation is not usually practical as a power source on anything but small systems requiring small ram forces. The cost of the gears and wheels, and the power loss through the system of belts, would be unacceptable.

The ratio of circumferences is in direct proportion to the speed ratio, while the ratio of diameters is a square root proportion. With a drive wheel of 2-inch diameter (1-inch radius), and circumference of 3.14 inches, the circumference of the driven wheel or cam in a single reduction system would have to be 133.97 inches! The diameter of this huge cam driver would be 42.64 inches, or about 3.55 feet!

Of course, with a train of gears, this could be handled nicely in a smaller package, but it would be expensive. Using a worm gear drive is the most practical method of reducing the speed. The friction caused by the high ratio worm gear reduces power considerably.

In a clock, high ratio reduction systems are practical because the total torque transfer is small. The gears can be tiny, fragile things that pack tightly into a small space. In a machine like this, the torque transfer is large. The gears must be beefy to handle it. Being strong and also having a high reduction ratio means they are going to be large and costly. It also means there will be quite a bit of power loss.

A power reloading press can utilize a cam or worm-gear drive system without undue cost because the required power is quite low compared to swaging. The amount of pressure required to size a case or seat a bullet is a fraction of the amount used to cold-flow metal into the shape of a bullet.

People who have not done the math or tried building swaging systems before often wonder why there are no multi-position swaging presses, either hand or power. Not only would the different steps of swaging a bullet require different amounts of pressure and insertion depth, but applying all of them in a three to six stage bullet-forming operation would mean building a huge power system to run it.

Inertial Storage of Rotational Electric Power

For most applications involving direct mechanical force, the energy is first stored in a heavy mass, by spinning a flywheel. As the speed of the flywheel builds up, it stores more energy. When it reaches designed speed, a trip is engaged to catch a tooth or gear on the moving flywheel and transfer its energy to a ram.

This system allows the motor to supply energy over a longer period of time than just one stroke. The motor can feed energy into the flywheel while components are being moved under the die, ejected, and during the return stroke. Typically, this kind of system only has full power at the bottom of the stroke (assuming the ram is on top, as with most punch presses). The cam or connecting-rod mechanism also develops its full power (minimum speed, maximum force) at the ends of the stroke.

This is an important concept to understand. The swaging process normally requires very little force while the component is moving into the die. Most of the ram force is required at the end of the stroke, when the components have stopped moving and are being expanded under high pressure. So, for swaging operations, the mechanical system seems to be ideal.

But when you include jacket forming, drawing, and other operations that utilize a great deal of force right from the entry of the component into the die, these systems fail to deliver the necessary energy in the right form until the press reaches massive size compared to air or oil pressure presses. The typical size of press required for single station bullet swaging needs at least a ram travel twice the length of the bullet, and a tonnage rating of between ten and twenty five tons.

The tonnage of a punch press is not quite the same thing as the actual ram force of a fluid power system, because the tonnage is only generated in full when the press has extended its stroke all the way. The ram is attached through a crankshaft or toggle in the typical punch press design. The energy stored in the spinning flywheel is applied to the crankshaft while the ram is at the top position, and the leverage that multiplies the force depends on the angle of the connecting rod.

The force available to flow the bullet materials when the ram is starting down, or when it is half an inch above the full stroke length, is considerably less than rated tonnage. It is necessary to purchase a much larger tonnage press in order to have the desired ram thrust available higher in the stroke.

Punch presses, eyelet presses, transfer presses, and other variations on the flywheel press are often used to punch and form sheet metal. With fraction of an inch thicknesses, the rated tonnage is close to being the amount available to punch, shear, and bend the work piece. But when long tubular parts are being formed, or when deep drawing cylinders like bullet jackets, full force may be required much higher in the stroke.

Inertial presses of twenty to fifty tons rated force are typically used for high volume production. The presses themselves generally are in the middle five to low six figure price range, new, without tooling. They require a fairly large operating area with moderately high ceiling, and generally use commercial three-phase power motors. The basic open back, inclined bed punch press can be used with a stack of dies, to make several drawing reductions in one pass.

OBI presses are usually the least costly design and are available in small tonnage sizes. I once used a little two-ton OBI press that I bought at a surplus machinery sale and carried to the trunk of my 240z sports car, then drove home with it comfortably resting on my overnight bag! It was far too small for bullet making but punched nice hole patterns in the cover for an electronic device that I was manufacturing. It was almost worth designing products just to see the little fellow punch the parts.

Eyelet presses are a kind of "dial feed" single station press. They use a rotary feed mechanism that positions the part under the ram, and moves it around to eject and load more parts. Transfer presses are usually multi-station, which means that the ram is attached to a number of punches or die shoe assemblies, all in a row. The work piece, which is normally a continuous strip of metal, is fed into the first station, and is advanced by a clever "shuttle feed" device from one position to the next.

The strip is fed into the first station with a strip feeder, which can use friction rollers or one-way spring-loaded gates that push the strip one direction but slide over the strip on the back stroke. Or air clamp cylinders can be used to grasp and move the strip forward. At the first station, the strip is cut or punched to make a "coin", for deep drawing operations. The coin may be left attached by thin flanges to the strip, so that the strip can be used to advance the part, or it may be cut free from the strip.

The shuttle feed is made as two halves of a multiple part clamp, which spread apart (open), move backward one position, close together (clamp), and then move forward one position. This motion is repeated over and over again, and has the effect of grasping a part, moving it to the next station, releasing it over the die hole, and moving back to get the next part.

I mentioned “die shoes” without explaining them. These are standard methods of holding and aligning the punches and dies so that they remain in alignment when you remove them from the press. The typical die shoe consists of a base plate, two or more hardened and ground support rods which are fitted with bearings within a sliding plate.

The base and sliding plate chomp up and down, powered by the press ram and supported within the opening of the press by being bolted or clamped in place. You can usually change the actual dies and punches fairly easily in the die shoe, which is a sort of intermediate mechanism between the press and the dies, providing the precision alignment instead of the press having to be built with high accuracy components to hold the dies and punches. .Die shoes are available in different configurations and sizes as more or less standard items, separate from the custom dies themselves.

In the Corbin swaging presses, we eliminate the die shoe and build the precision into the press head itself, and then standardize the dimensions of the dies and punches as far as their methods of holding and alignment, retaining the custom dimensions for the actual parts. We can do that, saving you thousands of dollars over the typical punch press system, because we are limiting the kind of products formed to a fairly small range of lengths and diameters in tubular forms (jackets and bullets, not car fenders, napkin holders and flashlight cases). The die shoe is a design feature that helps the punch press handle an extreme range of product sizes and shapes compared to the bullet and jacket making field, something you don't need if the press itself is designed for that field.

As you can see, the punch press is extremely versatile and can be used for anything from automobile fenders to flashlight cases. But the various complex feed devices and the die and punch sets themselves are not flexible. They are made to do one specific part, of one size, material, weight, shape... and they are very expensive because they must be built specifically for you, for each part you want to make.

When it comes to bullet swaging, a person wanting to use high speed punch presses will need to buy the press (a used one in the ten to fifty thousand dollar range would be about average investment) and then find a die designer to work out the blueprints and specifications for feeds and dies for the specific press to make your parts.

Once the tooling engineer has worked out the design, you need to take it to a tool and die shop and have them actually construct the tooling. Some of it will be universal, off-the-shelf component modules, and some of it will be built to blueprints. Once the tooling has been constructed according to your blueprints, you then need to get an experienced punch press setup person to put it all together and debug it, because no one involved in the process is responsible for final operation except you.

If the material tears or punches through instead of drawing, or if the parts stick on the punches, the tool and die shop will only be responsible for having made the parts to the tolerances specified on the blueprint. The tooling engineer will only be responsible for his design and not for the implementation of it, so that if any parts are not made correctly he is not going to take responsibility. And if you use a material with a different temper, tolerances, or grain structure than was specified, no one is responsible for it working but you.

Once when I was backlogged two and three years with jobs and simply didn't have enough available time to design my own jacket drawing dies for a high production press, I hired a firm who said they had deep drawing experience to both design some new jacket-drawing tools and build them. That way, the opportunity for finger-pointing was reduced since one firm would be responsible for both design and construction. But after four months and a few thousand dollars spent on "progress payments", the company gave up. They could not make the punch press form soft copper into jackets. Did I get my money back? Are you kidding?

What I got was what you or anyone else would get: a box full of parts including the die shoes and dies, a bill marked paid, and a suggestion to use some other material. That's just how it is with the tool and die business. You pay for people to try and you take your chances unless you know for certain that you already have a design with the correct tolerances and dimensions, and that if someone follows your plan exactly in making the tools, they will work.

If you leave it up to someone else to design your tooling, you might possibly have some recourse if in the end it doesn't work, but the odds are very good that one of about a hundred different escape clauses will leave you stuck with the bill and useless tools. The reason is that if you don't know enough about it to design the blueprints yourself, you probably don't know enough about the materials and setup to guarantee that you follow precisely what the designer intended. He might be able to make it work if he were the one who built the dies and set it all up, bought the material and ran the press. But of course, he doesn't do most of that. Someone else does. So at every step of the way, there is finger-pointing. It is always someone else's fault.

A few years later, when I had more time and some good die-makers working for me, we built tooling that drew pure copper strip into excellent bullet jackets. It took many years and tens of thousands of dollars to evolve to the level we have today. And the process has never stopped. I have no doubt that in five years, we'll be making tools that are faster and better still. Actually, the next set we make will have improvements that we didn't even consider necessary or possible yesterday. And our clients get the benefit of each thing we learn. Also, we are responsible for the design and the construction, and all the client has to accept is responsibility for using the right material and following our instructions (in order to get warranty service for any failure to produce the part specified).

Naturally, anyone can interfere with the operation of a precision process by failing to use the right material, or by using it incorrectly. But your level of responsibility is orders of magnitude less, when you buy a "turnkey" package designed around a specific material and guaranteed to make a certain part to specific tolerances.

You can't buy different material and expect it to always produce the same results as the material used to design the tools, nor can you decide to skip some steps or make changes in the lubrication, speed of operation, or physical parameters of the material and then hold the die-makers responsible if it doesn't work the same as it did with the right material and procedure. But that is a far cry from the risk you incur with tooling up a typical transfer press.

Because the tooling for inertial presses is designed around the handling between operations, most of the cost is in fact in the feeding of the parts rather than in the press or the forming dies themselves. It is hard to separate the feeding and forming costs, though, because the dies incorporate some of the feed system in most cases. As a general rule, the requirement for high volume, high speed operation is primarily a requirement for dedicated feeding systems for each part. The press and dies is slave to the feeding method that advances the parts through the process without human intervention.

The human hand is extremely versatile, and most people get two of them free, the ultimate robotic feed system in regard to instantly switching from one part size to another. True, it is slow. That is fine, in a market where 150,000 parts per year would be saturation, and the customers are willing to pay from fifty cents to as much as two dollars a bullet. The bulk of the gross profit goes to pay for your time, rather than going to pay for debt service on expensive machinery.

That is why the most versatile kind of press, requiring the least investment and size for the most versatility and capacity, is a fluid power press.

Pneumatic Pressure

The lowest-cost fluid power system is compressed air. The field of fluid power transmission includes both air and hydraulics. Both gas and liquid are considered “fluids” in this application.

Air, being composed of gasses (primarily nitrogen), behaves according to conventional physics rules for gas. That is, it takes up less volume and becomes more dense as pressure is increased, and it expands in volume or increases in pressure as temperature rises. Liquids are relatively incompressible compared to gasses, so they behave differently under pressure.

An air compressor might typically be capable of developing from 90 to 150 pounds per square inch of compressed air pressure. Since the typical internal die pressure required to form soft lead properly into a bullet shape, regardless of caliber, is about 15,000 to 20,000 psi (depending on die shape), a 4-inch diameter air cylinder would just barely have enough area to produce the force to swage a soft lead .357 caliber bullet, driven from a normal air compressor.

On the other hand, air pressure of only 90-100 psi on a 4-inch drive cylinder allows enough ram force to swage .224 and .243 rifle bullets very nicely. A pressure of 28,699 psi can be developed in a .224 inch die at just 90 psi of air pressure, using the 4-inch cylinder.

An air-driven swage press is practical for small calibers. It is possible to build a practical press to swage .308 rifle bullets, using only 125 psi air pressure, and a six-inch diameter drive cylinder. The internal die pressure can reach 37,949 psi with such a combination.

How much pressure is required? That depends on the jacket material, thickness, and core hardness as well as the bullet shape. It can range from a low of about 10,000 psi for soft lead with simple, easily formed ends to a high of more than 150,000 psi for heavy jacketed bullet brought to small tips. Our range of internal die pressures, practically speaking, spans a 15:1 ratio.

Internal die pressure is related to the square of the caliber, since the caliber is the diameter of the piston or punch that applies pressure to the material in the die. It is directly related to ram force. Thus, the ram force range has a 15:1 ratio for practical bullet forming operations. Ram force is in squared ratio to the drive cylinder diameter, but again in direct ratio to the drive pressure applied to the fluid or air in the drive cylinder.

With air equipment that is practical for non-laboratory use, the largest bullet than can be formed with certainty is a .308 caliber having a conventional thin jacket, no boattail, and fairly standard 6-S ogive. A soft lead .357 bullet can be formed with certainty in nearly all but the most complex nose and base shapes. Anything larger or more pointed, or having material any harder than soft lead for the core, is very likely NOT to form properly.

A cylinder larger than six inch diameter is not only very expensive but tends to introduce other problems, such as speed of actuation, oscillation in the system, requirements for excessive-sized feed lines to exhaust the cylinder, and multifarious conundrums beyond the scope of this discussion. The only other alternative is higher air pressure, and that is limited by the cost and availability of regulators, fittings, filters, and other appliances to control the system, not to mention the compressor itself.

Corbin built air presses for a number of years. They were marginally effective compared to hydraulic systems, but the demand was great enough to justify developing them. Cost on a 4-inch bore system is reasonable and if the bullet maker understands the limitations, and accepts them, then making .22 jackets from fired .22 cases and forming .224 to .357 bullets of certain types from soft lead can be done very nicely.

The air-over-oil system is a hybrid design wherein air pressure is applied to one side of a hydraulic cylinder, and the other side is filled with oil. This helps to eliminate some of the problems with pneumatic systems in regard to the “spring” or compressibility of air. It does not change the forces and pressures possible, but merely adds some additional control.

One of the problems with air systems is the instant action you get when you apply compressed air to the cylinder. It is restricted only by inertia and friction, which isn’t a lot of restriction, so it flies forward and back with virtually impact forces, a little bit like a punch press. The speed doesn’t really allow time for some materials to flow. It rips and tears the ends off bullet jackets, for example, and can generate rather excessive shock waves that crack swaging dies because the material acts as if it is much harder when you don’t give it time to flow from a freshly applied force.

The air-over-oil hybrid system gives more control over speed, since you can more easily meter the oil flow through a restrictor valve (speed control) than you can with air flow. Air speed controls are available but they are not usually as precise, reliable, and wide-ranging in their flow ratio adjustment.

When you are swaging a lead core, there is normally a physical stop set up so that you don’t continue to extrude lead until the entire core is gone. With core seating and point forming, sometimes a person wishes to use a certain pressure level as the sensing point to stop pressing. With hydraulics, the pressure is reached and the material is compressed in the die very uniformly. The ram can be stopped almost instantly by switching a valve, run by a pressure transducer.

With air, you can shut off the valve and yet the ram will continue to move for a noticeable time. Inertia and expansion within the system can cause problems on larger systems with movement when it should not be taking place. This is because air does compress, and shock waves can travel through it, causing movements after a valve is closed.

With hydraulics, the material transfers pressure instantly (or nearly so) throughout the entire system. The application or removal of pressure at one point has an almost immediate effect on the entire system. Movement is much more precisely limited by controlling the pressure. For bullet swaging, hydraulic power presses offer significant advantage over air presses.

The main physical difference between air and oil systems is the compressibility of the fluid: air is highly compressible, hydraulic fluid is almost incompressible. Hydraulic systems act more like flexible metal shafts, so that a shove on one end almost instantly transfers power at the other end. Air acts more like a big spring, where a push on one end eventually travels through the spring as it collapses in relation to the force.

Hydraulic pressure.

Hydraulics originally meant water power. A hydraulic-electric generator is a water-powered turbine. But in the fluid power field, it has come to mean oil or synthetic oil under pressure. Hydraulic fluid can be a water-based synthetic material or a light oil.

The oil is not designed for lubrication, but has low foaming when splashed around, low capacity to adsorb air and gasses under pressure, and is highly incompressible. It is made to maintain viscosity under high temperature and to transfer heat as well as possible. Certain pump and valve components are designed using materials that are compatible with either distilled petroleum or synthetic based hydraulic fluids. The solvent action of some fluids will destroy these components, so it is important to use the recommended hydraulic fluid.

Never mix types of hydraulic fluids unless the manufacturer of each fluid agrees that they are compatible. Never replace hydraulic fluid with motor oil or brake fluid. Just because it says "oil" doesn't mean you can use it on your salad, or in a precision press.

Another reason for using the correct fluid is that the pump is rated to handle a certain load, in a certain temperature range, with a specified viscosity or flow resistance of oil. If the fluid does not match this pressure and temperature range, it will break down and leak past the pump vanes. The pump will cavitate, the oil will further heat, and the pump seals can be destroyed. Further heating can cause pump seizure, destroying the rotor or the housing.

This is mentioned at the outset because it is important to use the correct fluid in a hydraulic system, and there seems to be quite a bit of confusion over what hydraulic fluid is. There are many grades and formulations, and quite a few are incompatible with each other and with the pump and valve components of some systems.

The hydraulic fluid used in Corbin presses at this writing is Chevron AW-46, which has cross-referenced equivalent numbers to other brands and is commonly available from hydraulic component suppliers, and from commercial oil distributors. This is an anti-foaming fluid that reduces cavitation and is usable over a fairly large range of temperatures. Extreme cold is not a suitable environment for operation.

The room in which the press is stored and used should be kept in the normal comfort range for human habitation (from 65 to 85 degrees F, preferably closer to 70 degrees F.). The viscosity of the hydraulic fluid increases with lowered temperature, so that operating the press or even starting the motor in a cold environment can draw too much current and blow a fuse or trip the 20 ampere circuit breaker / power switch.

If it is necessary to store the press at lower temperatures, the room should be slowly warmed to the proper operating temperature so that condensation is avoided. Once we received a Hydro-press for repairs, and every exposed steel component was coated with a layer of red rust. The press had been stored in an unheated shed, which was warmed up whenever the weather changed or the owner fired up a wood stove in preparation for making a few bullets. Moisture condensed on the precision steel components, which the owner failed to lubricate. The repairs consequently included replacing parts that would have been perfectly fine for several lifetimes if the room had just been warmed up slowly and a little rust-preventive oil wiped onto the exposed metal.

One might assume a person who cares enough to research and buy the finest machine of its kind, a machine with decades of research and development behind it, built by a die-works with a hard-earned, worldwide reputation for careful design and construction, should at least care enough about their investment to try to take the most basic care of the machine.

It's their money and none of my business once they take possession. I'm sure the people who design target pistols would have choice names for me if they saw how seldom their fine products are cleaned after a match. A family friend has an interesting turn of phrase, a result of not hearing the term correctly and then continuing to mispronounce it until it became ingrained habit: the phrase is "pig stein", which always brings to mind a "hogshead" of beer for some reason. The pistols continue to work fine, though, even the one's I've used for forty years, and I do clean them once in a while.

Still, lack of care seems like such a waste, especially when it takes so little to maintain the machine virtually forever. Some of the earliest Hydro-presses are now going on 30 years of service, having made millions of bullets. Some of them have never had the oil changed, and the only components replaced have been indicator bulbs on the control panel. I recommend changing the oil and the filter once after about 2000 hours of operation, but apparently this is precautionary rather than a necessity. The system is closed, there are no combustion products to contaminate the oil, and the only reason for deterioration is the fine particle accumulation that takes place from normal wearing of the pump rotor vanes (which the filter should trap).

Hydraulics have significant advantages over other drive types. A compact power system can deliver extreme pressures at moderate speeds. Control can be precise and easily adjusted with electronic sensors and logic. This opens the door to automatic control over system variables such as pressure, timing, speed and position.

The skill required to produce good bullets on a hand press includes the ability to sense a consistent pressure level by feel of the handle and ram resistance, and the sense of timing necessary to hold the ram forward the same time on each stroke. The electronics of a properly-designed hydraulic system can eliminate the need for this skill, and maintain consistency far beyond that possible by manual methods.

Hydraulic power by itself is not the answer to successful bullet production. Merely connecting a pump to a cylinder and slamming it back and forth in a mindless display of raw force will NOT make good bullets, and it probably will break dies and possibly injure the operator.

Control over the force, in the form of a logic and sensing system that is able to detect smaller variations than a person could possibly notice, and to act on them with greater speed than is possible by hand, repeating the expert performance reliably no matter how long the production run — that is the secret of making good bullets by hydraulic power.

The electronic system does not replace the operator, but extends his ability by doing his will more quickly and more precisely. It is not a “robot” that replaces the skilled hands, but a tool placed in those hands — a tool vastly more sensitive and at the same time more powerful than anything else available, but still under the control of the operator, and depending on his knowledge or on the knowledge of the person who set up the press. Once the knowledge has been applied, and the system is set up to make a perfect bullet of a given weight and shape, then the system can continue to repeat that performance regardless of who comes along to drop the parts into the die and press the buttons.

The bullet maker can walk along a row of such machines, setting each one up to do his bidding, check and adjust them to obtain the results he desires, and then put someone to work dropping parts into the die and pressing the buttons for the rest of the week.

This is the great advantage of such a system. Not only is it more powerful, for less cost, than anything else available, but it is capable of duplicating the skill of the bullet-maker, giving anyone the ability to produce a high quality bullet. At that point, it does become a replacement for skilled hands—but only after receiving “orders” from the higher authority of the bullet maker.

The hydraulic system can apply the same force at the bottom, middle, and top of the stroke. It does not have a limit on where the ram must be to develop maximum power. This means that operations such as jacket forming and bullet reduction are much easier. It means that lead wire extrusion is practical.

Practical hydraulic components of industrial quality (not farm or automotive components, which are built with dirty working environments as a main concern, and have life-spans more suitable for the average auto or combined growing seasons than industrial hydraulics) can be obtained with reasonable pricing with a maximum working pressure of 3000 psi (shock-rated) and 5000 psi static pressure (non-shock). The design of Corbin systems take advantage of the cost curve and use a 2000 psi pump so that components can be readily matched, yet provide a good margin of safety.

Higher pressures put the controls in a higher price category, while lower pressures reduce the range of functions or require much larger diameter drive cylinders and thus increase the cost of the system out of proportion to the benefits. Pressure also has a relationship to the kind of hydraulic lines used to plumb the press. Higher pressure on hydraulic lines places more torque or bending force on the connections and components except for straight-line connections, and is more likely to cause seepage or leaks. The entire system, including the weight and thickness of the cabinet and frame, is designed to match the pressure, bending movement of lines, and ultimately the horsepower of the drive motor.

Rigid steel line costs less than flexible hose, but it is more difficult to fit and replace. It is subject to fracture at the flared fittings from vibration or repeated stress, which causes seepage of oil. Vibration and shipping stresses, such as sudden stops and accelerations, can shake heavy components or flex the cabinet slightly, and loosen or crack the connections made with solid steel tubing.

Replacement of steel tubing requires either precisely preformed bends and lengths of exactness that may not be practical, or the custom-fitting of tubing by the installer using tubing benders, cutters, flaring tools and wrenches.

Flexible hydraulic tubing uses more expensive fittings and is itself considerably more costly than steel line, but if properly sized with generous loops, it can better handle mechanical stress and can also be replaced with nothing more than an open-end wrench. The design of the cabinet, routing of the hoses, and mounting of components becomes more critical with flexible tubing, since the oil pressure will try to "uncoil" loops or straighten U-bends. The force can be enough to break mounting bolts, bend or break housings and unscrew the connectors if the effects of hose torque are not taken into consideration. In some cases it may be necessary to secure the loops by mounting to solid structural supports so that the torque is not so great on the fittings.

Ram thrust, drive pressure, and internal die pressure are related but not the same thing. It is important to understand the differences. With a range of from 100 psi to 2000 psi on the gage (drive pressure), a cylinder of 3.25-inch diameter can produce a ram thrust of 829.58 to 16,591.54 pounds. This thrust is independent of caliber, depending only on the applied pressure and cylinder diameter. At 2000 psi on the gage, the press is developing a thrust of 8.3 tons.

This thrust, however, must be channeled through the face of a punch to apply pressure within the die. To transform the ram thrust into die pressure, we must know the caliber (diameter) of the punch. The formula, written using computer math notation, is...

$$P_d = F/A_d$$

...in English, this means divide the force of the ram, in pounds (F), by the Area of the punch tip in square inches (A_d). Die pressure (P_d) is in pounds per square inch. The area of the punch tip is given by the formula...

$$A_d = Pi * C^2 / 4$$

...where Pi is 3.14159.... (number of times the diameter of a circle will go into its circumference), and C is the caliber or diameter of the punch. You could replace $C^2/4$ with half the caliber, or radius, squared, since the area of a circle is also Pi * r^2.

As the diameter of the bullet gets smaller, the pressure that is produced in the die with the same ram thrust goes up very quickly (in proportion to the squared caliber). Smaller calibers, then, require far less ram thrust than larger ones to develop enough pressure so that the lead flows and the bullet forms correctly. Lead flows at a certain pressure, depending on temperature and exact alloy composition, that is usually about 15,000 psi in a smooth-sided cylindrical die. It takes about 20,000 psi to form a good replica of the inside of the die using a normal jacket over the lead.

This is not related to caliber, drive cylinder size, or oil pressure. In other words, soft lead at normal room temperature will flow well enough for swaging at 15,000 psi no matter what the caliber. This is internal pressure on the lead, within the die. The force that it takes to generate that pressure is very much dependent on the diameter of the die. This is why you can easily swage a jacketed bullet in a small reloading press, in .224 caliber, but increasing it to .458 caliber requires vastly more effort and might overstress the components of typical reloading presses.

The figure of 15,000 psi is a bit arbitrary. Lead starts to flow under very small stress, even at 1000 psi. There are instances where tall buildings have been built with pads of lead sheet between the concrete foundation pilings and the support columns, as a way to spread the force evenly and allow for some expansion movement. After years of being under pressure, the lead was found to be slowly extruding, with a creep rate of a few thousandths of an inch per year!

The rate of lead flow under lower pressures is extremely slow. As pressure is increased, the speed of movement goes up. The range of 15,000 to 20,000 psi is a high enough estimate so that soft lead cores inside a normal gilding metal jacket of 0.015 to 0.027 inch wall thickness will form completely in standard bullet dies, within half a second or less. This is long enough to get the job done at a reasonable pressure without excessive conscious effort to maintain a specific dwell time with hand press operation. (With a power press, the dwell time can be precisely dialed up and repeated automatically.)

The pressure within the hydraulic system that is necessary to form a bullet depends on both the caliber and the size of the drive cylinder. We've just shown how to calculate ram force from required die pressure and caliber. Now, here is how to calculate the oil pressure necessary to develop any given ram force...

$$P_s = F/A_s$$

...which means, the hydraulic system pressure (P_s) equals the ram force (F) divided by the area of the system drive cylinder (A_s).

The area of the cylinder, A_s, is equal to the square of its diameter times Pi (3.14159) divided by 4. This is the same formula as the area of the punch tip. We can put this all into one formula by saying that the gage pressure is equal to the die pressure times the square of the die diameter, divided by the square of the drive cylinder diameter...

$$P_s = P_d * C^2 / D^2$$

In the case of the Corbin Hydro-press with its 3.25" drive cylinder, the formula is...

$$P_s = P_d * C^2 / 10.5625$$

Conversely, to find out what pressure you would apply to any given size of bullet swage die, multiply the gage pressure times the square of the diameter of the drive cylinder, and divide that by the square of the diameter of the swage die bore (or punch tip).

The formula for die pressure is...

$$P_d = P_s * D^2 / C^2$$

This brings up one other minor problem: how much pressure can you apply before the die breaks? And, how do you know before it happens so you can avoid it?

With a hand press, there is almost no good way to tell. You must learn by "feel" and approach maximum pressures with caution, just as you do in reloading. In the Corbin Hydro-press, a gage reads system pressure directly in PSI. You can easily look up the caliber (or diameter of die) in the tables provided in this book, then read the maximum allowable pressure for a standard Hydro-press die. Set the automatic pressure reverse or the pressure limit for that pressure or slightly less, operate with the suggested approach speed to avoid excess shock, and you will not break your die.

The amount of pressure needed will be considerably less, usually, than the breaking pressure. If you reach the breaking pressure, and the bullet still has not formed up correctly, then the job cannot be done using that particular material in that die. It is up to you to quit at that point. Check the tables. Thousands of dollars worth of tests and piles of broken dies have been created to test the tables in this book. If you continue, you will probably break the die. That may provide full employment for our die-makers, but it does your bottom line no good at all. I recommend against it (counter to the advice of our accountants, who think it would be a capital idea). What if the job cannot be done with a standard die? Must you give up?

No, there are three more choices. You can change materials so that you find a material that flows more readily. Usually the material you are using is too hard and won't flow readily. Or, you can drill a hole in the end of the metal slug, so that there is a relief for the compression of the metal. Drilling over halfway through a piece of brass rod with a 1/8-inch drill will remove enough of the center so that you can form a solid brass .50 caliber machine gun bullet in one stroke from a half-inch diameter rod.

Or, you can order a special die. Corbin can make them in a larger diameter than standard for special applications. The limit of special die diameters is reached when you need over 200,000 psi.

It should not be necessary for you to need this much pressure. But that is the limit regardless of die size since it is the tensile strength of the strongest alloy we use, less about 50,000 psi for safety margin. The standard die for the Hydro-press is 1.5-inch diameter. Increasing the diameter to two inches will increase the allowable strength several tons on a big bore, but hardly make any difference on a small bore. The formula for die strength is given in the next chapter.

The design of the Hydro-press is such that the die fits into the ram. The ram moves vertically. You are thus able to drop your bullet into the die. The internal punch fits down into the ram, and pushes the bullet back out of the die on the bottom of the stroke. Then, the ram can be set to move up a short distance so the internal punch is retracted slightly. This opens up the die, so to speak, so that you can drop the bullet in and not have to hold it when the press is running.

All Corbin presses have vertical rams with the die fitted to the ram. Two manual models and three hydraulic models are produced at this writing. Although most of the discussion here is directed to the Hydro-press, please bear in mind that in some situations you may be nearly as well served by one of the smaller hydraulic or even manual systems.

Any power press should have a means for alignment of the bullet and punches in the die that does NOT require the operator to hold the bullet or the punch. In the Hydro-press, two buttons are provided as a safety measure. They are located on the front top panel so you can easily press one with the right hand, and one with the left hand. At no time should it be necessary to reach into the area of the moving ram, but if you DO lift your hand from either button, the ram will stop.

Sometimes, it is more convenient to let the ram continue to move up and down while parts are put into and taken out of the ram. An example would be sizing a long run of cases, using the reloading adapter and shell holder. Because we are adults and responsible for our actions, there is a key switch on the Hydro-press that allows the operator to select automatic operation. When the key is put in this position, a red light comes on as a warning.

Pressing the right button (UP), holding it down and then pressing the left button (ENERGIZE), is half the sequence that sets up automatic ram operation. If you lift your hand off the left (ENERGIZE) button first, and then release the right (UP) button, the sequence of events finishes programming the logic for automatic ram movement. The ram continues to move with both buttons released.

The left (ENERGIZE) button is then programmed to act as an emergency stop, and the yellow DOWN button is set to override all other functions except emergency stop. Press and release the ENERGIZE button to stop the ram. Press the yellow DOWN button to reverse it, but be aware it will go up again by itself when you release the DOWN button.

The automatic sequence should only be used by an adult who is alert and willing to pay careful attention to what he is doing. Any press as powerful as the Hydro-press can cause serious injury to the hands. The key can be removed in the manual position to prevent anyone from ever using the automatic function. The motor (pump) switch still controls the system and can shut it off.

It is encouraging to note that there has never been a reported injury using the Hydro-press. The speed of ram travel, clearance between steel support plates, and design of the control system all contribute to a safe operation, even with pressures of two thousand atmospheres routinely generated!

Swaging Pressures

The pressure necessary within a swaging die is determined by core hardness, jacket hardness, and the resistance generated by the shape of the die and punch faces. To some extent it is affected by die finish, although a die must be extremely well finished to work at all.

Pressures generated in any given die are limited by the tensile strength of the die material, die wall thickness, and thus by both die diameter and bullet diameter. Since dies are generally short compared to their diameter, the length of the die has no significant effect on die strength.

Typical pressures to form pure lead bullets range from a low of 10,000 psi to a high of 22,000 psi. An alloy of 2% antimony with lead, which increases the hardness from Bh 5 to about Bh 8, can easily double the required pressure to as much as 45,000 psi.

It is very important to understand the difference between internal die pressure, which has meaning independent of the system in which it is used and remains fixed for the performance of a given job, and the ram thrust and system pressure. These latter two measurements mean nothing without reference to a given drive cylinder diameter and a given caliber of die.

When someone asks, "How much pressure does it produce?", I always wonder if they'll understand the significance of the answer. Any given design of bullet will require exactly the same pressure to produce, whether it is made on a hand press or a Hydro-press.

The press will only produce as much pressure as the resistance provides. No matter if the gage could be made to read hundreds of tons of pressure, the hydraulic system merely responds to resistance. If it meets no resistance, it produces no pressure.

When you put lead in a die, and the die has bleed holes to let you extrude some of the surplus lead, the pressure will only rise until the resistance from the flow of lead through those holes matches the ram thrust. Moving the ram faster increases the pressure only because greater resistance to the flow occurs at higher velocity. If you set the press for a limit of only 500 psi on the gage, then it will never produce more than 500 psi within the system itself.

But, if this same 500 psi that always produces 4,147.88 pounds of ram thrust in the Corbin Hydro-press is generated in some other system, it could produce any ram thrust the builder desired. Whatever size drive cylinder is used will determine whether that is a puny pressure or a dangerous one.

For instance, 500 psi with a 4-inch cylinder produces 6,280 pounds of thrust. With a 6-inch cylinder, that translates to 14,130 pounds. And with a 12-inch cylinder, it creates 56,520 pounds — over 28 tons!

So, for someone to ask how much pressure the press produces is rather interesting. Unless they know the drive cylinder diameter and the diameter of the swage die, any number is as good as another! The press can produce whatever pressure you want, given the right size of die and drive cylinder. The drive cylinder diameter of the Hydro-press is 3.25 inches. This corresponds to an area of 8.29577 square inches. Force is equal to pressure times area.

But the ram thrust or press tonnage is not very useful information unless you relate it to a die bore size. The same force that produces 35,703 psi inside a .172 caliber die would barely register 4,029 psi in a .50 machine gun die (.512"). That pressure, in the Hydro-press, is produced by a mere 100 psi on the gage.

The amount of pressure the press can produce in a die depends on the bore size of the die. The smaller the bore size, the higher the pressure it can produce. There is an interesting correspondence between the rapid rise in pressure that the same ram thrust produces in smaller bores, and the increase in die strength as you make the hole smaller. The die strength goes up, too. But it doesn't go up nearly as fast.

For instance, that .172 die in a standard 1.5-inch Hydro-press design can hold 185,905 psi internal pressure. The .512 die can hold 102,198 psi before it breaks. Yet, in order to break the .172 die, all you have to see on the system gage is a mere 520.7 psi. To break the .512 die, you would need to generate a system pressure of 2,536 psi (beyond the normal system capability).

So, even though the press could easily generate far in excess of 200,000 psi in a .172 die without straining itself, the die would be blown to bits before the gage read 600 psi. And even though the press can, in fact, produce 200,000 psi, if you had a .512 diameter die installed, the maximum pressure you will ever generate with the press set for its maximum of 2000 psi is 80,580 psi in the die.

Don't let the pressure scare you. When a die blows up, it releases all the pressure as soon as a crack forms. There is very little energy packed into that pressure. A firearm holding back 80,000 psi would have a tremendous amount of stored energy at that level. A swage die has only a tiny bit by comparison. As soon as the die breaks, the pressure is gone.

Dies usually break in two parts, very neatly. Core swage dies, which have three bleed holes at 120-degrees around the circumference, usually break through the bleed holes because that is the point of least resistance. Sometimes they will break and remain connected, so you barely notice it except for the loud "bang" that the 200,000 psi alloy emits when it breaks. It is a little like the amount of energy stored in a bike tire versus the energy stored, at the same pressure level, in a big air compressor tank. Both might be 90 psi. If one breaks, it throws a bit of rubber a few feet. If the other breaks, it takes out the building!

Since it is quite important to control the pressure, and it is obvious that you can easily break some of the dies with very low gage readings, it becomes important to know how to determine breaking pressure. The Hydro-press has pressure controls that give you complete ability to set the limits to safe levels for any die.

A chart in the back of this book lists all standard calibers and their breaking strength in a conventional Hydro-press die. The breaking pressure, ram thrust, and gage pressure are all listed. As long as you read the maximum gage pressure in this chart, and set up your press so that it cannot possibly reach or exceed this level, your die cannot be broken from excess pressure, with two exceptions: (1) point forming dies have a curved ogive shape which effectively reduces their bore size as you approach the tip, and (2) dies with bleed holes can be broken if you try to force high strength material through the tiny holes or try to move normal material through them too fast.

In effect, in both instances, the actual bore diameter where the pressure is being applied is much smaller than the caliber of the die. Instead of using the caliber, you need to use the diameter of the hole where you intend to force material under pressure. In some cases, the hole is very tiny indeed, and the ram thrust must be reduced greatly in order to limit the pressure at this point.

If you put a small, hard piece of metal (such as a copper rod or brass jacket) into a tapered cavity (or point forming) die and force it to expand to fill the die cavity, you will be applying concentrated force against a smaller diameter than the actual bore (shank portion) of the die. To calculate the safe limit, use the diameter of your rod or jacket at the point of initial contact instead of the die caliber, and set your limit for that bore size.

I need to stress that the hardness of the material that you are swaging has absolutely no effect on the pressure that you decide to apply. Sometimes a person will crack a die because they put a hard lead alloy or a piece of solid copper into a die, and then just kept applying more and more pressure because the material would not form at a normal, safe pressure. The hard material did not crack the die. The pressure that was applied did it. You are in complete control of the pressure, and can stop trying to form any material that is too hard any time you wish.

Likewise, using soft enough material in the die only guarantees that it will flow and make the proper shape bullet at a safe pressure. It does not automatically reach over and grab the pressure control and turn it down to the safe pressure you ought to be using. Certainly you can leave the pressure turned way up from forming a .458 bullet and blow up a .224 die using anything for material. It is really wishful thinking to send a broken die back with a note saying “This die must be defective: it broke using soft lead”.

Corbin offers a low-cost computer program that can calculate the breaking strength of any swage die, for any caliber, diameter, or material strength, and also translates maximum pressures from one system to another, so that you can easily determine the pressure within any caliber of die regardless of the cylinder size or gage reading. This is available under the catalog number DC-DIES. (It isn't actually an obituary.) A pressure-related program that concentrates on wire extrusion, powder metal compacting, and press designs, is called DC-LEAD. Both are useful in the design of swaging and extruding presses, and in using the proper levels of pressure.

Die pressure is easy to calculate. It is merely the ram thrust divided by the area of the punch tip. No matter what shape the punch tip may have, if you look at it straight on, it has an area that corresponds to the bore of the die. For practical purposes, you could say the die bore area is the same.

But, remember that the caliber is not the same as the diameter when you have a core swage or core seating die. The core swage must be smaller by at least twice the jacket wall thickness. That can make a considerable difference in the pressure calculations. With a core swage die, use the punch diameter. Do the same for a core seater. The jacket effectively reduces the area when you are seating cores. All the ram force is pushed through the area of the punch tip.

This means you could use the .375 caliber chart to find the limit of pressure for a .375 core swage die and blow it up as a result, since your particular set might use a .065" wall jacket and thus the core swage would be more nearly .243 caliber!

Here is the formula for determining maximum internal die pressure...

$$P_{max} = (2st^2 + 2stC)/(2t^2 + 2tC + C^2)$$

where...
t = the thickness of the die wall, and...
C = the caliber or die bore
s = tensile strength of the die material

The thickness of the die wall is merely...

$$t = (D - C)/2$$

...where
D = outside diameter of the die
C = caliber or die bore

The thickness necessary to hold any given pressure is found by using this formula...

$$t = (C/2) * (SQR((s+P_{max})/(s-P_{max}))-1)$$

...where
C = caliber or die bore
P_{max} = maximum internal pressure
t = die wall thickness
s = die material tensile strength

...and SQR stands for the square root symbol as in many programming languages.

I have written all the equations in a manner that would be simple to insert in computer statements, although raising a number to an exponent power is usually written like this: n^2 ...because there is no way to actually compile or interpret a superscript character in most programming languages. Also, I used subscripts to make the variables a little shorter and more clearly indicative of their value, whereas if you want to put these equations in a computer program, you'll need to make up distinct variable names.

In relation to the Hydro-press dies, the die wall thickness, "t", is found by using a die diameter of .900 inches. This is the diameter of the thread root and relief groove in the shank, the smallest part of the die. This area normally has little or no pressure acting normal to its inside surface, but it is better to be safe than sorry.

If you replace the "t" with the quantity...

$$(.900 - C)/2$$

...in the pressure equation, and replace the "s" with the 200,000 psi tensile strength of Corbin's heat-treated dies, then the equation reduces to...

$$P_{max} = (200{,}000 * 0.81 - C^2)/(0.81 + C^2)$$

This is a specific equation for the Corbin Hydro-press die series, which are the "type -H" dies. They can be used in the Corbin Mega-Mite^tm, the discontinued Hydro Junior^tm, and Hydro-Press^tm models.

To find the gage pressure for the Corbin Hydro-press, you can use this formula...

$$P_s = (3.25 * P_{max} * C^2 * Pi)/8.2957679$$

You're right: the tables and the software program are a lot quicker. The program runs from a simple menu. You can generate information about any kind of die material, diameter, caliber, gage pressure, translate one system pressure to another, find ram tonnage and thrust, and much more—hundreds of pages more information than I could possibly print in this book.

Die pressure, then, is something that is related to press tonnage but has many other factors. The pressure you actually need to use, versus the pressure that the die can withstand, both need to be translated to a gage reading for your press, so that you can easily set and monitor the safe operating pressure level, always using the least pressure that gets the job done consistently.

The tables in this book make it simple with the Corbin Hydro-press system, and are one reason why it makes good sense to consider a standard, well-tested and researched system even if you are perfectly capable of building your own press or have access to any number of powerful presses. The data relating to their use would have to be developed by rather costly experimenting. It has already been done for the Hydro-press system.

In the years 2000-2003 I supplied Hydro-presses to the U.S. Army advanced armament research and development lab (AARDEC) at Picatinny Arsenal, and was asked to come to the New Jersey facilities a couple of times to train researchers in the use of the press and dies for the “Green Bullet” project. This was a much-publicized initiative to convert most of our military small arms ammunition to use environmentally friendly projectiles.

The concept of “safe” bullets caused some humor but really, the idea makes sense since far more bullets are fired in training than in combat. The bullets all land on our soil, at the various training bases. Millions of rounds of lead eventually build up in the berms to each toxic salts into the water tables. Most of the bases are located near large population centers, so contamination of the water table is a concern. No one actually gives a hoot whether the next sniper round that hits a terrorist is filled with potentially toxic metal or not, although that is where the jokes were all aimed.

When I arrived the first time at the lab, I was met by two Ph.D.’s in physics who were in charge of the actual research, both of them civilians. The Hydro-presses were set near the end of a nearly block-long building that probably dated from the 1920’s. Inside were millions of dollars worth of laboratory gear, including a hydrogen atmosphere furnace and a gigantic hydraulic press that stood at least two stories tall through a huge cutout in the floor, where a basement was excavated to make room for at least half of its height.

During our conversations, I asked Dr. Kapoor, the main fellow in charge at that time, why they bought CHP-1 presses instead of just using some of the existing massive equipment. He paused for a second, weighed his thoughts, and said, “They do not have the control we need.” Then he turned and indicated the monster press that was lurking just over our shoulders, and muttered, “We are afraid to use it.”

At first I thought this was a joke, but the further I became involved in the project, the more I realized the wisdom behind the comment. We were working very close to the dies, metering in precise amounts of powdered metals and swaging them one at a time to test the results. The pressures were experimental and the results were not yet known. Some operations shattered the punches the first time they were tried. Without the precise control of position, pressure, and timing, it really could be dangerous to try some of these things with the much more expensive machines already in place.

We also supplied tooling for Oak Ridge National Labs, Sandia Labs, Lockheed and to Martin-Marietta when they were separate concerns (that puts the date stamp on me), to DuPont Textile Division (during Viet Nam for development of woven aircraft armor), to Lawrence-Livermore Labs, and to folks at the Los Alamos labs, among many facilities who had the resources to get anything they wanted. I know that if someone wanted to spend the money, we could build fancier presses, bigger presses, presses with more automation. But the performance of the standard CHP-1, which you or anyone else can get from stock 90% of the time, was just right for the task of building serious prototype bullets.

I mention this not from an excess of ego (I got over that a long time ago when I was shooting on a Navy pistol team sponsored by the officers of the guided missile frigate U.S.S. Josephus Daniels out of Norfolk, came in second to a gunny sergeant of the U.S. Marines, and had to sing the Marine Hymn to the other team). Naturally I’m proud that our equipment has been selected by so many top arms developers, and of any small role it might have played in advancing our country’s defense.

But my real point is that you don’t need to spend more money on a system to get exactly what most serious research and development people use. You can be certain that if there was anything better suited to developing prototype projectiles, none of these agencies would have purchased anything less. As it was, they saved thousands of dollars over the next nearest priced, similar quality press and got exactly what they needed. That's our tax money being saved, yours and mine!

Whether or not you agree with the wisdom of what was developed, it would have been developed anyway by someone. That being so, the best thing for all of us is that American research and development people have the most cost effective solution. Not the cheapest, because that may be shoddy and ineffective in the long run. Not the most costly, if it doesn't really provide useful value for the extra money. But the equipment that gives them the most useful tool for the job. If it leaves money in the budget for something else, that's even better.

At this writing, (March 2017 revision of the original text), Corbin makes two hand-operated swaging presses and two hydraulic power presses. The hand presses are the CSP-1 S-press, and the CSP-2 Mega Mite press. The hydraulic presses are the CSP-1H Hydro-Mite press, and the CHP-1 Hydro-press.

The CSP-1 and CSP-1H both use -S type dies, with 5/8-24 threaded tenons which fit into the press ram, and a 7/8-14 threaded punch holder in the press head.

The CSP-2 and CHP-1 presses both use -H type dies, which have 1-in x 12 pitch threaded dies for the ram, and a 1.5 x 12 threaded punch holder fits the press head.

All of the presses can be used with standard 7/8-14 reloading dies and the button shell holders made popular by RCBS. Adapters are used for the ram. In the CSP-1H a special recessed bushing allows a longer stroke without crashing the shell holder into the bushing, and it is optional because not many people buy the smaller hydraulic press for reloading.

On the other hand, the other Corbin presses all come with reloading adapters since they are frequently used with standard reloading dies and shell holders as a side benefit, or sometimes as the primary reason for purchase. The CSP-2 and the CHP-1 can also use 1-1/2 x 12 thread reloading dies, and 7/8-14 threaded shell holders, which are a popular standard for 50 BMG reloading equipment. Adapters for the ram are provided with these presses.

Lead Wire Production

Lead wire extrusion can be a profitable adjutant to bullet manufacture. It is useful in the bullet-maker's own product line rather than using purchased lead wire or casting cores. Lead wire can be sold to fishermen, sporting good stores, and other bullet makers with a return of up to 400 percent on investment.

Unfortunately, even with such good rates of return, the market is not large enough to support full-time lead production in most areas. But as a supplement to other products, lead wire brings in enough to more than justify the initial investment.

The commercial production of lead wire requires a power press. A hand press is too slow, and does not develop enough power to handle the required volume in one billet except for very small wire sizes. It will be shown later that almost any press can extrude lead wire, but with the exception of very small diameters, the length of lead you can extrude in one stroke with any hand press is not enough to justify the attempt.

Lead extrusion requires that the raw lead be formed into a billet (a cylinder of lead that will fit into the extruder die) by casting. There are three ways to get the billets. One is to cast them yourself. This requires a large lead pot such as those used by smelters. It also requires natural gas or propane, since electric heat is rather expensive for this operation.

The fire danger, health hazard, and physical location may all combine to make casting scrap lead into billets an impractical task. Billets can be purchased from a lead supplier. This reduces the profit in many cases to as little as 100% return on investment. However, it eliminates some of the investment and all the fire insurance, zoning, and health problems associated with melting lead.

Another alternative is to put someone else in business as a part-time supplier of lead billets for you. Find someone who has a country location, who doesn't mind the fumes and has room for the big lead furnace, and who would enjoy spending a few days every month melting several hundred pounds of lead, perhaps several thousand pounds later on.

The molds can be honed tubes fitted to steel bases. Corbin makes billet molds from cylinder tubing, hones them smooth inside, and fits them to self-supporting bases. The tube slips over the plug base. Molten lead is poured into the tube and allowed to cool, and another billet mold is filled in the interval. Then the first one is picked up and an empty tube placed over the same plug base.

Every few pours, the first tube is given a rapid vertical shake (with five pound or smaller size billets — a machine is used to push the billets from larger mold tubes). The lead billet slides out, and the empty tube is put back on the base again.

Billet sizes from one pound in .79 inch diameter (used in the Hydro-press) to 25 pound size in 4-inch diameter are typically used. A tiny extruder for the reloading press or S-press, used to make small amounts of .120" lead wire for sub-calibers, takes a billet of only about 500 grains. That is typical of what one can extrude with a hand press.

It is common for people to underestimate the size of hydraulic system required to extrude a given size, weight, or length of lead wire. The Hydro-press, for instance, runs an oil pressure of 2000 psi on a 3.25-inch cylinder and can extrude a .79" diameter billet that weighs about one pound.

A 10-pound extruder system might use a cylinder with an eight inch bore, running 2000 psi. This press has a ram force over 100,000 pounds, which is fifty tons. It can extrude soft lead wire from a billet of up to two inch diameter, through a hole as small as .125 inches. Using a six inch bore drive cylinder, with 2000 psi, the minimum wire diameter that can be extruded is .185 inches from a billet no larger than 2 inches. This is a force of 56,520 pounds or 28 tons.

With a four inch bore cylinder and 2000 pounds, it is barely possible to extrude a one-inch diameter billet through a .312 inch hole. Practically speaking, it would be best to limit the extrusion to no smaller than .365 inch diameter wire. This is a ram force of 25,120 pounds, or 12.56 tons.

The lead hardness, temperature, pump pressure and ratio of the billet cross-sectional area to the cross-sectional area of the extruded wire is what determines how big a cylinder will be required. The weight of lead produced from one billet can then be determined from the length of the billet. A practical length for a cylinder of reasonable price is not greater than four times its bore diameter.

That is, the price of a typical four-inch bore cylinder starts to become excessive, compared to a larger bore cylinder, when you look at lengths of stroke greater than 16 inches.

The price of a six-inch bore cylinder longer in stroke than two feet would pay for getting an eight-inch bore cylinder in most cases, and the price of an eight-inch cylinder with a stroke of 32 inches or more would just about get you a ten-inch bore cylinder. This assumes that you are attempting to extrude the same volume of lead.

Volume of lead goes up directly, cubic inch per linear inch, with cylinder stroke length. But it goes up with the square of the cylinder diameter. So, you have to double the stroke to get twice the volume, but you only need to increase the diameter by 1.41421356...

If you are paying more than twice as much money for doubling the stroke, yet are paying less than twice as much to increase the bore size at least 1.414 times, then you are getting more lead volume extrusion for the money if you select the next bigger cylinder diameter.

Of course, we are talking about cylinders that cost thousands of dollars here, so lead extrusion in large volume is something to consider carefully. Cylinders large enough to handle a four-inch billet, for example, and extrude wire in the practical range of from .125-inch to .5-inch diameter in spools of 25 pounds would have to be nearly a foot in diameter and have a stroke twice the billet length, which in a four inch, twenty-five pound billet means a 20 inch stroke.

Such a billet would produce 414 feet of pure lead wire in .125" diameter, or about 66.5 feet of pure lead wire in .312" diameter. If the lead was not pure, but had a density of .393 lb / in^3 instead of .4097 lb / in^3, then the first example would produce 432 feet of lead in .125" diameter and the stroke would have to be almost an inch longer to handle the extra volume.

In the second example, a .312" diameter wire would turn out 69.3 feet long instead of 66.5 for pure lead, and the stroke length would be just about an inch longer to do it. As the hardness of lead goes up, the density goes down, and the volume required for a certain weight goes up. Unfortunately, lead hardness greatly increases the necessary pressure for extrusion. Typically, lead wire is pure lead, 99.995% being the purity supplied by Corbin in 10-lb spools.

The formula for determining the weight of lead in a given billet size is...

$$W = 0.7854 * B_d^2 * B_L * Dens$$

...where
W = Weight of billet (or spool) in pounds
B_d = Billet diameter in inches
B_L = Billet length in inches
Dens = Density of the lead in pounds per cubic inch

Conversely, the length of billet and stroke in a machine with removable die (so stroke is only marginally longer than actual billet length) is found by the formula...

$$B_L = 1.273 * W/(B_d^2 * Dens)$$

Typical lead density for soft lead is 0.4097 lb. / cu-in. It can range to .406 lb. / cu-in without causing undue concern. Less dense alloys are hard to extrude, and may crack. Extremely hard alloys come out as coarse powder, or at least as very fragile rod that breaks up far too easily to be coiled, depending on the formulation of the alloy.

The formula for determining necessary extruder pressure for a given size of billet is proprietary, since it cost so much to develop in both equipment and time. You'll have to forgive me for not including it in this book. I'm not anxious to give potential copycat competitors that much help!

I will give you a formula that represents an approximation of the required force, though it doesn't consider some of the innovations we've used to make our systems more efficient. To determine the drive cylinder diameter required for a given billet diameter to be extruded to a given wire size, you can use this equation...

$$D_c = 1.273 * (1/P) * (B_d/W_d)^2 * s$$

...where
D_c = diameter of extruder cylinder,
P = system pressure, psi
B_d = Billet diameter in inches
W_d = Wire diameter in inches
s = tensile strength of the lead

This formula will give you an idea of the size of drive cylinder required to extrude a given billet into a given wire diameter with a given amount of oil pressure available. There is also a software program available from Corbin that will instantly calculate wire length, billet length, spool and billet weight, wire diameter, lead density, and other parameters related to wire extrusion. It is called DC-LEAD, and also includes optional calculations for powdered metal bullet swaging, such as effective density, compression ratios, and powdered metal mixtures.

Extruders can be built vertically or horizontally. A vertical extruder takes up less floor space, but is more difficult to move and to load and unload. A horizontal extruder is easier to transport and can be easier to use, but takes up more floor space. Also the drag caused by gravity means that the cylinder, die, ram, and other components will tend to sag out of alignment unless the entire assembly is constructed with heavier framing than a vertical one.

Using a six-inch diameter extruder for making five pound spools of lead wire with a two-inch diameter billet, the head plate that keeps the die in place and resists the thrust against the extruder ring needs to be two inches thick if machined from cold rolled steel! Otherwise, even with four stout tie rods, the plate will probably warp under normal operating force.

There are two ways to push the lead out. One is to move a piston behind the billet, forcing the entire billet to move along the die. This is traditional and works well if the ratio of die length to diameter is not too great. The friction of the lead along the die walls can greatly increase the required force, otherwise.

Lead wire extrusion requires lubrication of the billet. A generous wipe-down with Corbin Swage Lube will cut the resistance along the die walls by half, making it possible to extrude wire in smaller sizes. If appropriate measures are taken to reduce the force required, harder alloys than pure lead can be extruded. But there are practical limits to the hardness of lead that can be extruded.

It is best to avoid lead with more than 6 percent antimony, or equivalent hardness in a tin-lead mixture. If the hardness goes over Bh12, it is likely that the lead will extrude poorly or not at all. Wheel weight alloys vary considerably over time and from region to region. Wheel weights are not standards to judge hardness, and can contain zinc, sand, tin, antimony, arsenic, and other materials. Extruding lead with sand and road grit mixed in it will soon wreck the extruder dies.

Reclaimed battery lead is one of the major sources of commercial production. More lead is reclaimed from automobile batteries than is mined, making lead one of the most recycled of all metals. Battery lead is not safe to reclaim at home, however. Alloy removal is a dangerous process for anyone but a smelter. It involves deadly gasses, boiling lead (something that puts lead vapor into the air in uncontrolled environments), and is generally not feasible at home.

Lead sold as "pure" may in fact be reclaimed battery lead with 99.95% lead and a trace of silver. Lead that contains more than one tenth of a percent of other metals is certainly not pure, however, even for our purposes. If it has a tensile strength of 1000 or less, and a hardness of Bhn 5, we can safely assume it will work as well as "pure" lead, regardless of its actual composition.

To determine the Brinell hardness number, you can perform this relatively simple procedure:

1. Obtain a known pure lead sample, and melt it into a bottle cap.
2. Prepare another bottle cap by filling it with your test material.
3. When both bottle caps have cooled, place a ball bearing between them, sandwiched against the two lead surfaces. The bearing should be from 5mm to 10mm in diameter.
4. Squeeze the sandwich in a vise so that the ball bearing is driven part way into each lead surface, but not as far as half way.
5. Measure the diameter of the two dents with a dial caliper, square both diameters, and divide the smaller number into the larger one, then multiply the answer by five.

The answer is the Bhn of the unknown sample. The accuracy is limited only by the purity of your soft lead sample, and your ability to read the diameter accurately. Corbin can supply pure lead samples for comparison testing.

Heating the extruder die to increase the ductility of the lead, and reduce the system power requirements, is an alternative to building a larger extruder. However, it only works moderately well in spite of the potential reduction of 50% in the resistance for every 100 degree increase in temperature. The reason is the thermal mass of the system.

The extruder die would have to adsorb and hold a vast amount of heat in order to maintain the lead billet at a high temperature during extrusion. Bringing the die and its associated massive steel supports to a temperature several hundred degrees above ambient level would cost a great deal in both time and electricity.

As soon as the lead is inserted, it begins to transfer heat to the frame of the extruder. The mass of the lead billet has to be heated completely through in order to reduce the resistance enough to make any difference. If the lead billet is first heated and then inserted into the extruder, by the time extrusion actually starts the lead will have lost most of its heat into the die and cylinder walls.

Thus, it would be necessary to pump heat into the die constantly. And since the steel would only transfer heat at a certain rate to the smaller surface of the billet, but would radiate heat at a faster rate from the greater outside surface area, the rate of heat transfer would have to be rather high from the source to the die. The outside of the extruder would need to be insulated to reduce radiation.

Most wraparound heaters don't provide enough caloric volume, or quantity of heat in a short enough period of time, to make the extruder operate continuously. You would have to shut down everything but the heaters every time you loaded a billet, and wait a fairly long time for the billet to heat up. Even if the billet is preheated, if the die and cylinder is not provided with a fairly powerful source of constant heat, the billet will cool too quickly..

The final problem is lubrication. Sufficient lubricant on the billet will reduce the required system pressure considerably with most extruder designs. In fact, leaving off the lubricant can cause the machine to stall completely, failing to extrude anything. But heating the billet normally causes the lubricant to become less effective, perhaps even oxidizing or becoming a fire hazard.

With larger extruders, system power can be increased to five, seven and a half, or ten horsepower using 220 and 440 volt three-phase motors. This means that such machines could not be run in a home environment, since three phase power is typically not available there. But it does increase the margin for flaunting the rules. With enough power one can skip lubrication without stalling the machine.

Speed of extrusion is quite fast even with very slow ram movement, since the speed is relative to the diameter of wire being produced. The volume of lead that passes a point is constant whether in the die at full billet diameter, and moving at only a few fractional parts of an inch every second, or whether the point is taken outside the die, where the much smaller diameter means that the same volume of lead now is packed into a much longer piece.

Moving the same volume at smaller diameter automatically means moving more feet per minute past a given point. So, the ram moves slowly, but the lead shoots out like someone stepped on the toothpaste tube! In the Corbin's 3/4-inch LED-1 extruder for the Hydro-press, the ram moves about an inch per second, taking nearly five seconds to push the entire billet out the die. But during that time, the lead comes out fast and hot — you have to wear gloves to avoid unpleasant burns.

The movement is fast enough with small diameters so that it should be guided into a box using a long piece of plastic guttering or large diameter tubing arranged to catch the lead when it spurts out of the die. An angled deflector arranged over the die top will direct the lead wire in the direction of the chute, and once it is aligned and moving down the chute, it will head for the box faster than a person could guide it by hand.

The formula for determining how fast the lead is going to come out is...

$$R_w = (B_d/W_d)^2 * R_b$$

...where
R_w = Rate of wire movement, inches/second.
B_d = Billet diameter, inches.
W_d = Wire diameter, inches.
R_b = Rate of ram travel, inches/second

A rae of .5 inches per second on a two-inch billet translates to 233.7 inches per second when extruding .185-inch diameter wire. That is 19.48 feet per second, fast enough to make you notice.

When extruding wire, it is critically important that you never place your body over the opening of the die. In other words, have the wire bend around a guide or feed it onto the spool in such a way that no one is ever in the line extending from the bore of the extruder ring die.

This advice could save your life. I have seen lead wire trap a bubble of air or lubricant, and compress it between two pieces of the billet (especially when someone puts two sections of lead into the die instead of one solid billet). The pressure inside the extruder is extreme. There is a fair amount of energy stored in the compressed air bubble. It moves forward until it is just below the opening, with a piece of lead in front of it.

This is a blueprint for a high powered air rifle! There is a lead wire, acting like a bullet, in front of a bubble of compressed air that will move, in a fraction of a second, just into the opening of the extruder ring die. If the bubble is about the size of the extruder die hole (wire size), then nothing connects the rapidly extruding wire to the billet at that second. It is free to fly.

There is a hole in my garage ceiling, right through the plywood, where one of the first extruders fired a shot in this manner. Fortunately, no one was peering down into the die to watch the lead come out. I have only seen it happen twice. But it can happen. Beware! Treat the end of the extruder as if it were a loaded rifle. Put a guard or shield in its path, or make sure it points the lead in a safe direction as it comes out.

And don't reach in front of the die when you are spooling the wire. This was from the Hydro-press extruder, which used a .79-inch billet and a 3.25-inch drive cylinder at 2000 psi. Of course, the lead pressure is about the same in any extruder system. It is only the ram thrust that goes through the roof as the billet size is increased. Lead still moves at the same internal pressure no matter how much of it there might be in the die. The length and die shape create friction that is significant, but still the pressure required to flow lead is dependent on temperature and alloy. It has nothing to do with the rest of the system.

Extruders can be made, as I mentioned, in a fixed or removable die version. With the fixed die version, the stroke must be long enough so that a billet can be placed behind the die and pushed into it. The stroke is twice the billet length plus at least twice the diameter of the billet to allow alignment. You simply drop a billet onto a guide, or drop it into the die from the top in a vertical system. The ram then moves "fast forward" as quickly as oil can be pumped into the cylinder, often using a dual displacement pump with automatic shuttle valve to switch to high pressure and slower movement when resistance is met.

To use a foot-long billet with this system would require a two foot ram travel plus a bit more for alignment room in the die. This adds to the cost of the system, so another method is also used. The removable die can take several forms. Two of them are the cup die and the open tube die.

The cup die is closed on one end or has the extruder ring mounted in it (so it is nearly closed). The tube die is open on both ends and is closed either by having a screw-on or bayonet-lug fastening, or by fitting snugly against a base when it is in the machine.

The cup die is removed from the machine, loaded with a billet, and placed back on the machine. Several dies could be used, but they are quite expensive. The tube die can be fixed to the machine and have a removable end cap to load in the billet.

It too can be removed, but since it is open on both ends, it is lower cost to make and can be loaded from either end. The wall thickness of the die can be calculated using the same formula as for bullet swages. The punch is actually a ram. It can have a floating head that aligns in the die, or the assembly can be made very rigid with a solid head, and precision of the unit will keep the ram centered in the die.

Because the forces are so high in such a system, the ram can be driven into the die wall if there is any misalignment, destroying the die. It is critical to keep punch and die alignment in the range of 0.001 inches or less. This is not great precision in a die only an inch long, but when the die is as much as two feet long, and weighs fifty pounds or more, it can be a problem.

A variation on the tube die is the pivoting die, wherein the extrusion cylinder is hinged to the press head and the extruder orifice is mounted in the head. To load this press, you swing the cylinder to one side, insert the lead billet, and then swing the cylinder back into alignment with the ram. The hinge and the locking pin that secures the cylinder to the press head must, of course, be very stout. In some extruders, an auxiliary ram moves a tubular clamp forward, surrounding the actual pressure ram, and uses this to hold the extruder cylinder in place against the press head.

Extruders can also make hollow lead tubing with only slight modification. A billet is cast using a wire stinger in the middle of the tube mold. The hole through the billet lets you mount a fixed rod or wire in the center of the extruder die, passing out the ring die opening. As lead is extruded, it flows both through the die hole and around the central wire, leaving a hole through the center of the entire spool.

The force on the wire is extreme, so that 1/8-inch wires have been pulled apart during extrusion. Spring wire is normally used for strength. The purpose of hollow lead wire is for solder, primer cord sheath, and acid tubing. It can also be used for fishing sinker wire. Lead wire can be formed in various geometric shapes, for the stained glass industry. This form of lead extrusion is called "came". It is often formed as H-shape cross section channels, to hold two pieces of glass together or as a U-shape cross section for edging. The shape comes from a carefully cut and polished extruder orifice.

The actual die insert or orifice is normally made with the side facing the lead as a very slight angle to a smooth radius that leads to the tightest constriction right away, not as a deep funnel. There is frequently a relief hole on the output side, or a counter-bore, which reduces the amount of drag applied to the lead wire while maintaining the strength of the die.

In most cases, you cannot insert a second billet and have it join the wire from a previous billet. The junction is usually poor, and separates when the wire is coiled on a spool. Oxides and carbonates form on the surface of pure lead almost immediately in our atmosphere. This is what makes lead stable and protects it from further deterioration. Some forms of lead decomposition are porous and flaky, but the most common oxidation forms a tough film that resists further deterioration. Unfortunately, it also resists binding with another piece of lead, since there will be two layers of oxide between the pure lead masses. The billet size should be an even multiple of the weight of your finished wire spools, plus a small amount for scrap that is always left in the orifice die and should be pushed out or cut off the end of the next extrusion.

The bottom line is that lead wire can be a profitable product for the bullet maker as long as the size of the system is kept in reason. All considered, the beginning bullet maker may wish to produce wire in short pieces, perhaps a foot to eighteen inches long, using the LED–1 extruder kit with the Corbin Hydro-press, rather than purchasing a large extruder system. Wire can be packaged in straight lengths and sold this way, rather than on spools.

Then, after having established that there is a market for lead wire, and arranging for someone to produce larger billets at a reasonable cost, a machine capable of running five to ten pounds of lead at one time might be feasible. To produce more than this becomes quite expensive, and involves logistics of an industrial nature: power, space, and noise as well as the licensing and environmental concerns may push the idea beyond practical limits.

In order to determine just how big a system you might need, in terms of pressure and drive cylinder size, run the program "DC-LEAD" with the particular alloy hardness, wire diameter, and billet size that you want to use. It may surprise you just how large a system it takes to produce a ten pound spool of wire with the smaller sizes. You'll also quickly see one of the reasons that alloyed lead wire is infrequently found on the market. The size of system required increases rather dramatically as you increase the hardness and thus the resistance to flow.

Another reason why alloy lead is harder to find in wire form is that there are infinite ratios of lead to other alloying agents. Unless a firm were to take custom orders rather than selling from stock, it would be hard to know what to stock. Cash flow could be severely restricted, because too much inventory would sit on the shelves unsold, locking up money that should be working. A custom "fabricator", as the lead extruding firms are called, would need to secure an order large enough to justify melting and mixing enough to pay for cleaning out the pot before and after, and for extruding enough material to use at least one complete billet for their size of machine.

In most instances, a commercial lead supplier needs to sell from half a ton to a full ton at a time in order to make the run worthwhile. If you only want to buy 50 or 100 pounds of alloy wire, it would be a little like asking Winchester if they'd make you a couple of pounds of gunpowder in some special formulation so you could try it.

This presents an opportunity for a home business to make and advertise small runs of alloy lead in national gun magazines. The LED-1 extruder die isn't suitable, but a custom die can be built, and for that matter, we have built dedicated custom extruder machines for making straight lengths of wire using harder alloys. The cost is far more than the Hydro-press, since it takes a much larger drive system and very heavy structural components, but it can be done on special order.

CHP-1 Hydro-press^{tm} Set-Up

The Hydro-press has three electronic position sensors, for top, load position, and bottom of stroke. It also has switches to turn on the pressure reversing function, automatic reversing by position at top of stroke, settable dwell time for both top and bottom of stroke, and a key switch that has off, manual, and automatic settings. There are additional switches for load position, which programs the press to stop at the loading position after ejecting at the bottom of the stroke, and control knobs for the reversing pressure as well as the drive pressure.

In addition, the Hydro-press contains additional relays and circuitry that can be used to operate automatic feeders and other accessories, and has a twist-lock two-prong socket near the rear of the cabinet top that provides power to an automatic stripper plate, for jacket drawing. This is primarily used with the JMK-2-H automatic jacket maker system.

The Hydro-press uses a 1.5-horsepower motor and with either a dedicated 20-ampere (115-125v) or 10-ampere (220-240 volt) circuit. With the export version, a multi-tap power transformer inside the case can be set to run on any voltage from 205 to 250 volts, 50 or 60 hz. This is a power option not required for use within the USA or Canada.

The first thing you have to do is get the press unpacked and set up. Don't let the truck line tip it on its side to off-load! Insist on the use of a lift tailgate. If the local connection doesn't have one available, then you will need to arrange for a fork lift or a couple of stout buddies to help you get it off the truck in a vertical position. The press weighs about 350 pounds in the shipping carton.

There is a 15-degree line marked on the side of the box. If the press is tipped past this line, oil can be spilled through the breather cap, and air can be admitted into the intake line. These are not major issues but they cause some inconveniences, like cleaning up inside the cabinet or operating at low cycle rate for a while to clear the air back to the tank.

Look at the box carefully, and make the delivery man sign on the bill of lading to verify any apparent leakage or damage before you accept delivery. It doesn't happen often, but sometimes a truck line will disregard all the warnings and toss the box off a truck, lay it over on one side, or even drop it off upside down.

The truck line is liable for the damage. There is no excuse for it. Your first step should be to get a signature from the driver to the effect that there was apparent damage. Sign the receipt with a note "Received in Damaged Condition". Next, call the truck line immediately and tell them you want to file a claim. Ask them if you can open the box before the adjuster arrives, to assess the damage. Don't throw away anything, certainly not the box or skids to which it is fastened. Keep them around to show an insurance adjuster if one should be called in later.

Call Corbin right away and let us know, too. Normally, you have to handle the claim at your end but we can help. An absolute minimum claim of five percent of the value of the package is what we would recommend in the event you cannot tell how much damage was done. It normally would cost freight both ways to have the machine returned, repaired, and sent back, and the truck company must cover this at least.

Second, if the cabinet is destroyed or badly dented in, we should rebuild or replace the machine. The equipment inside is probably not hurt, but alignment needs to be checked out and even if the cosmetics are not important to you, you did pay for a very fine looking piece of equipment and you deserve to get it in that condition. The safest thing to do is to file a claim for the full value including shipping costs. The adjuster isn't going to pay you a cent more than he has to, and your starting point is the most you'll be able to get.

We select our freight firm based on good service and quality delivery. We change immediately when that is violated. They know it, so they don't usually give much trouble on claims — there usually aren't more than two, before they are out the door forever. But, they don't always have a choice about who routes the shipment from their last major terminal to your door. Deregulation or not, there aren't always a lot of short-haul outfits available in every neck of the woods.

The outfit that actually comes to your door, then, may not be the one we hired to haul the machine. That's just how it is. Make sure you can be there for unloading and check the box for signs of oil leakage. All that having been said, I'll also say it is rare to have any problems and all this is not meant to scare you, just to cover all the possibilities. It's best to be ready for the worst that can happen, so you will be in control.

So, here it is, delivered without a hitch. No oil-soaked bottom to the box, no dented-in top. You'll probably want to borrow a little hand truck or a couple of friends to help you get it in your garage or shop. It isn't big, but you shouldn't tip it over.

Once inside, snip the bands around the carton. Pry the nails that hold the box onto the skids. Then, lift the box carefully up and off the machine. If you don't have room to do this, you can very carefully cut the box down one corner, but don't poke the knife too far inside. That is one tough box, and it has lots of reinforcing inside. You might want to save it, if you have room.

Whatever you do, save the box until you are sure the press works correctly and was not damaged in shipping. Claims without a box may not be honored by the truck line.

There will be cardboard and tape to remove, and possibly some rust-retardant coating to wipe off with solvent (on the polished steel guide rods). Overseas shipments nearly always have salt-spray resistant coatings to remove.

Some people like to leave the machine on its wooden skids. I would prefer to remove the two by four ledge and set the machine on the floor. The heavy power cord is meant to be plugged into standard 115 volt 60 Hz. power, standard in the U.S.A. Machines built for overseas shipment are normally provided without a plug, so that standard 220 volt plugs may be attached depending on the country and conventions of the local power supplier.

The green wire is neutral or ground. The black wire is "hot" or 220-240 volts, and the white wire is the return or common (in U.S.A. standard systems, the black wire is 115-125 volts compared to the neutral green wire).

The domestic version should be operated on a circuit capable of supplying 20 amps peak current, with a motor-rated delayed fuse or breaker. The press itself has a built-in 20 amp breaker switch (the pump switch is, in fact, a switch-rated breaker). The logic circuits have their own 5 amp push-button breaker (a little button toward the rear of the top panel).

The machine is normally shipped ready to run. It is filled with the proper grade of oil, unless a notice is attached stating otherwise. The proper hydraulic oil is ISO-46. Corbin provides this in gallon containers. You don't have to prepare the press, other than unpacking and cleaning up.

Find the key to the switch, and turn the key switch off. Turn off all the other switches. Turn the two dwell timer control knobs to zero or the lowest setting. Remove the FPH-1 floating punch holder from the press head, if it is sent installed. (It may be inside a box of accessory parts.) This is a large cylindrical threaded steel part with a bushing screwed into one end, described in the press instruction sheets. It is used to hold and position external punches. There should be no dies or punches in the press ram or head at this time.

Double check the preliminary settings. Make sure. The instructions may not produce the right results if switches are in the wrong position, and it will be very difficult to help you figure out what is wrong, because we are assuming that the press is set up in the standard pattern.

If the circuit into which you plug the CHP-1 has lots of other appliances on it, you may have problems with tripped breakers or possibly overheating and stalling of the press due to low voltage. If you have any doubts, you may want an electrician to check and make sure the plug will handle a 20 amp peak load with a 1.5 HP motor (on 115 volt systems) or 10 amp load on 220 volt systems.

Check the two fans on the side of the cabinet for dented or damaged grills. See if they are pushed in against the fan blades. If they are, you may want to file a damage claim, or possibly just pull them back out into alignment again if this is the only apparent damage. This would be a rare problem. Any problem with this system is rare. It is generally one of the most trouble-free products especially considering its complexity and size.

Plug in the press. Do not "go around" the 3-prong outlet by using an adapter. Get a proper 3-prong grounded connector. You don't need a fire at the plug due to the contact resistance of a light-duty adapter. It doesn't cost nearly as much for the wiring of a new plug as it does to replace your shop.

Turn on the work light. There is a switch on the lamp fixture. If it doesn't light up, check to see if the bulb is screwed in correctly. Then check the bulb—try a known good one or try that one in another socket. Don't turn on the machine yet. If the bulb is good and doesn't light up, unplug the machine and take the front panel off. Look inside and see if you notice any wires loose from the lamp or the key switch.

Get a qualified electrician to repair them. Have him give us a call while he's there and we can walk him through the procedure. The wiring is too complex and it is too dangerous to fool around inside unless you know what you are doing.

Assuming the lamp comes on, put the key in the switch and turn it to the ON position. Now, stop and check that there are no parts stuck in the slot in the ram. You should have a steel bar and a steel pin that can be removed from the ram. The bar is the ejector bar, about a quarter inch thick and six inches long. The pin is about the same length, nearly a quarter inch in diameter. Remove these parts for now. If they are trapped by the spring, just make sure they are centered with equal amounts on both sides of the ram. You can remove them in a minute when the ram is moved up.

If you do not find the retraction pin or the ejector bar, look in the packaging for a bag or box that might contain them. When the press is tested, we normally leave these parts in it, but years go by and procedures change. It could be that by the time you read this, we've decided to package the parts separately. If you still can't find them, call us and we'll get spares on the way.

With the key in the ON position, you should hear two fans come on. If you don't hear anything, check the fans to see if they are turning. If not, turn off the machine and unplug it, check inside for loose or disconnected wiring, and call an electrician! If the fans come on, everything is OK up to the key switch. There is a small circuit breaker near the back of the top panel. It enables the logic circuits. This button should be down so that you cannot see a white ring around the button.

If you can see a white ring around the button, the button needs to be pressed down until it clicks and stays down. If it should pop up again during normal operation, something is wrong. It should never pop up unless there is a short circuit. But you can use it as a safety to keep unauthorized people from operating the press, even if they do find the key. To disable the press except for fans and work lamp, pull UP on the button until you see the white ring. Then try to remember that you did it, so you won't think the press is broken next time you try to use it!

Flip the switch marked “PUMP” to the ON position. There should be an immediate motor sound as the pump motor starts. If you don’t hear this, turn off the switch, unplug the machine, and check for loose wires from the pump switch to the motor. By loose, I mean not connected. The machines are thoroughly checked before shipping, including at least half a day of run-time. But vibration during shipping can cause some odd things.

If at any point you feel compelled to take either front or back cover off the cabinet, you may as well leave it off for a little while so you can check for leaks once the machine is running. Leaks occur when vibration loosens the fittings on the hydraulic lines. Any leak you can actually see needs attention. A tiny bit of seepage at the top of the cylinder rod is normal, but it should only exist as a very thin film of oil on the cylinder rod. If it drips, something is amiss.

The sound of the motor is about like a vacuum sweeper. It isn’t quiet enough to run in a thin-walled apartment at night, but it isn’t loud enough so that you couldn’t hold a phone conversation in the next room. If it is annoying to you, a good way to handle long runs of work is to use a pair of good stereo headphones connected to your favorite radio or stereo! Most people don’t find it unpleasant. It’s the sound of money about to be made, and the start of good experiences for a lot of your future customers!

When you first turn on the machine, the ram should not move. Make sure the ejector bar and extraction pin mentioned earlier are not stuck part way through the ram. Then, press the ENERGIZE button by itself. Nothing should happen. Now, hold down the ENERGIZE (green) button and at the same time, press the UP button (red).

Assuming the ram was not at the top of the stroke already, it should start to move up. Release the red button. The ram should stop. Check carefully to make sure that the position sensors mounted alongside the path of the ram on a steel standard do not stick out far enough to be struck by the ram. (On the discontinued Hydro Junior, the very tips of the limit switches need to contact the ram.)

If they look like they would clear the ram and are not loose, press the ENERGIZE and UP buttons again. The ram should move up. If the ram did not move either time, it is possible that air bubbles were generated during the move. The air bubbles in the lines have to circulate back to the tank. Hold down the two buttons for a little while, perhaps two minutes. The ram should start to move, perhaps with a jerky motion.

Release the buttons. Press the ENERGIZE and the DOWN (yellow) buttons down. The ram should start to move down. If you run the oil back and forth for a little while, not over five minutes, you will work the bubbles out of the lines and the ram will start to move instantly and smoothly when you press the buttons.

Notice that there is a delay on the down motion. This delay depends on where the knob setting the dwell time is set. This knob is near the back of the panel. If you turn it all the way in one direction, it will take about ten seconds for the ram to start to go down. But in any case, there should be a yellow light immediately. This light tells you that the timer is working and the ram will go down if you hold the down button long enough.

When you have got the ram moving smoothly up and down, run it up until you can remove the knockout bar and ejection pin from the slot in the ram. They just pull straight out. These pieces don't need to be there right now, and they might get in the way. If they were not shipped in the ram, they should be somewhere in the packaging with the press.

Run the ram to the top of its stroke. Notice whether it stops and the motor quiets down and the gage quits reading anything at the top, or whether the motor remains loud and the gage continues reading as long as you hold the UP and ENERGIZE buttons. The top position sensor always controls the top of stroke position, even if the position switch is off. With it off, the ram will stop and the pump will switch to idle. With it on, the ram will stop, then the yellow light will come on, and finally the ram will reverse if you hold the UP button long enough. If the dwell timer for the top of the stroke is set to zero, the ram will reverse immediately when the yellow light comes on.

Check for a small red light on the side of the position sensor. This light will come on whenever there is metal in front of the sensor, within the distance of a quarter's thickness. There should be about enough room for a regular quarter (US twenty-five cent piece) to pass between the side of the guide plate and the face of the sensor.

You can check any sensor by holding a steel screwdriver blade in front of it. With none of the buttons pressed, the red light should come on whenever you get within about 0.05-inches of the face of the sensor. You can stop and reverse the press by holding a screwdriver in front of the top sensor.

If the red LED light on the top sensor is ON, then the top sensor is controlling the ram and the stop position will depend on where you move the top sensor. Once you move it past the physical limit of the ram travel, then the ram will continue to try to go up as long as you hold the buttons. Under these circumstances, you can see and adjust the maximum system pressure.

Move the top sensor as high as it can go. Press the ENERGIZE and UP buttons. The ram should go to the top and keep trying to go further. The gage should show some pressure and the motor should sound loud. The red light on the top sensor will not come on.

Note the pressure reading on the gage. Turn the PRESSURE SET knob about half a turn one way or the other, press the buttons again, and note the change in reading. You can quickly tell which way increases the pressure, and which way decreases it. Turn the knob so that you get about 500 psi on the gage.

If you don't see any pressure difference, make sure you are turning the actual drive pressure set knob, not the pressure reverse knob. (This latter only adjusts a trip point for a switch, and does not control the system pressure. Pressure reversing is used to automatically reverse the ram whenever a set pressure level is reached.)

If the part you are forming will form nicely at 100 psi, then that is all the pressure you will need. Using more is not helpful. When the ram is moving up or down, you will only read supply line resistance and the pressure required to overcome system inertia and friction.

There are three points at which the ram will stop moving: These are:

1. The physical limit of the cylinder.
2. The point at which the top sensor gains control (anywhere below the physical limit).
3. The point at which there is enough resistance to equal the maximum system pressure (in other words, a stalled cylinder).

Suppose you are trying to form a bullet. You have set the top sensor to stop the ram just as the bullet enters the die. Will you ever form the bullet? Of course not. The bullet just starts in, and the sensor stops (and, with POSITION on, reverses) the ram. Suppose you move the punch holder a little lower. Now the external punch pushes the bullet further into the die at the same ram position. You start to form the bullet.

How can you tell if the ram is stalled, the sensor stops the ram, or the physical limit is reached? First, never work at or close to the physical limit unless you are actually depending on it to stop the ram. (In some high precision forming operations, the end of the cylinder stroke is used as a positive, absolute stopping position).

For most operations, move the top sensor a good inch below the physical top of cylinder stroke position. You don’t need to waste that much time moving the ram, except for very big, very heavy bullets. You’ve got six inches of ram travel to play with, meaning that you can make a three inch long bullet with ease.

Second, check for the red light on the sensor. If it comes on, then it is in control. If not, something else is getting there first.

Third, check the gage. If it reads a constant pressure at the end of the stroke, you are not reaching the sensor position. The ram is stalled. Increase the pressure setting a little at a time, but stay below the maximum safe rating for each size of die cavity (not just caliber—actual bore diameter).

Play with the press for a while until you have a good understanding of the role of the top sensor, the physical cylinder limit, and the pressure control. You need to understand these things very well before you try swaging bullets. They are not hard to understand, but like anything else, a little experience and "feel" for how it works is a valuable addition to just the "book learning".

You probably wouldn't get much more from a lesson here at the die-works, except for faster confidence that it all works as expected. Often people will schedule flights from other countries and plan to spend several days "training" here, only to discover that once they've seen it and run the press up and down a few times, they have a very good grasp of how it works, and they might have saved the air fare and hotel bills by doing the same thing at home.

But I suspect the real advantage is psychological. Once a person has visited and seen the vast array of bullets produced by other clients over the past 45 years, it removes any lingering doubts about viability of custom bullet making. Just seeing three decades of prototype presses hanging on the wall near the test benches affirms the amount of thought and work that has already gone into the products they have ordered.

The bottom sensor needs to be adjusted less frequently than the top one. It sets the point at which the internal punch pushes up just far enough to eject the bullet. If you lower it too far, the ram will either bottom out against the punch head and knockout bar, and stall the cylinder, or the physical limit of travel on the other end of the cylinder will be reached.

There is a large coil spring around the ram, used to push down on the retraction pin. This spring can become "coil bound" or crushed together if you allow the bottom position sensor to be set too low. The spring should always have at least a small gap between its coils when the ram is all the way down. Some dies have internal punches that require positive retraction when the ram goes up, because otherwise the open end of a jacket might be formed around them. To make sure these punches are pulled down, out of the main die cavity, when the ram goes up, a retraction pin is placed through a hole in the head of the punch. The pin projects on both sides of the ram, through a slot.

In order to get the pin under the big spring, the press ram is run up to take the force off the spring. Then the retraction pin is placed through the slot, through the hole in the head of the punch, with the spring bearing lightly on top of it. The spring is between the moving ram guide plate and the retraction pin.

The knockout bar (or ejector bar) goes through the same slot, under the pin. It is used to stop the internal punch when the ram goes down to the point where the knockout bar comes to rest on the base plate, so that the die continues to drop with the ram and the internal punch is held from going further down. This pushes the bullet out of the die (ejection).

With any of the sensors, check the red LED on the side of the sensor body to determine if it is activated. Also check the reading on the pressure gage. You can tell if the sensor has control if the LED is on, and the gage reading drops to zero (meaning that the oil flow to the drive cylinder has been shunted back to the hydraulic reservoir, and no pressure is being applied to the ram)

The proper position for the bottom sensor is set by putting the die and punch into the ram, and installing the knockout bar (and, in the case of point forming dies and other dies with a small hole in the punch head for retraction, the retracting rod).

Caution: when the knockout bar is in the ram slot, watch the big coil spring and stop before you compress it completely. With the knockout bar in place, you can over-compress the spring. With it removed, there isn't much chance of this happening. Remove it for your initial experiments, and you'll avoid damage to this powerful spring.

The spring performs retraction of the internal punch on those dies which require positive retraction. Point form dies and some other types do. Many do not need it. Those which need it have a hole drilled through the punch head. The steel rod goes through the ram, beneath the coil spring, but on top of the knockout bar. The notch in the edge of the knockout bar keeps it from sliding out of the ram slot. The retraction rod or cross pin is pushed down by the spring. It is easiest to install when the ram is UP, and impossible to install with the ram all the way down.

The retraction pin must be passed through the ram slot, through the hole in the head of the internal punch, and have the spring pressing on top of it. The idea is that the spring pushes cross pin down, and the pin pushes the internal punch down. This pulls the pin out of the die cavity when the ram goes UP. The knockout bar rides along in the ram slot, below the pin and under the head of the internal punch.

When the ram goes down, the knockout bar comes to rest on the base plate. (The base plate is the large inch-thick block of steel through which the ram travels and on which are mounted the two support rods for the press guide plate and press top plate.) The knockout bar stops against the base plate, but the ram continues down. This holds the internal punch while the die continues down and thus ejects the bullet. If you try to use the cross pin (or retraction rod) UNDER the head of the internal punch, it not only defeats the purpose but messes up the careful calculation of punch head length compared to the depth of hole in the ram, and will cause problems. If there is no hole in the head of the internal punch, don't try to use the cross pin with it.

When using a lead wire extruder or draw die, remove both the retraction pin and the knockout bar. With the bar in place, you can crush the spring by going too far down. With no internal punch to stop the ram, you probably WILL go further than usual. It's your spring, but I'd want to avoid replacing mine.

Replacing it isn't too hard, though: remove the two nuts on the top of the press head plate, set a block of wood on top of the ram and guide plate, and use the press to gently push the press head plate off the two guide and support rods. Unplug the press and remove the back cover on the cabinet. Unscrew the two nuts that hold the support rods against the bottom plate, then unscrew the two rods from the bottom plate (do NOT use a pipe wrench or other tools that will mar and destroy the surface of the rods!). Slide the two guide rods up and out of their bearings on the ram guide plate.

Then loosen the setscrew in the front of the guide plate that holds it to the ram, and unscrew the guide plate from the top of the ram. Then, you can get the old spring off and put a new one on. Assemble in reverse order. Align the press head with the ram while tightening the two top nuts. An alignment jig is available from Corbin to assure exact centering on any Corbin press. One is used for presses with 1-1/2 inch by 12 thread top plates, and another for the S-press and others using 7/8 inch by 14 thread top plates. Or you can use a dial indicator and a bit of trial and error adjustment. Tightening the top nuts tends to move the position of the top plate unless it is held securely in some manner, such as the alignment jig which fits the press ram and passes through the threaded center hole.

The functions described for the Hydro-press also apply, in so far as the features are present, with both the Mega-Mite hand press and the Mega-Mite Hydraulic press. The Mega-Mite uses the -H dies, exactly the same as the Hydro-press. It is designed either to help you work your way up to a Hydro-press later, without replacing all your dies, or as an aid to production once you have a Hydro-press and are so busy filling orders that you wish you could buy another one, but don't quite have the funds available yet. The Mega-Mite can handle many of the jobs which are typically run at low pressures on the Hydro-press. If the job requires only 100 psi or so, then you can probably do it on the Mega-Mite.

One of the major differences between the Hydro-press and the Mega-Mite press is that the hand press has a fixed bottom and top of stroke position determined by the linkage. This means that using different lengths of dies requires matching different heights of knockout bars in the hand press, while one dimension of knockout bar will work with the same dies in the Hydro-press (by adjusting the bottom sensor position). The combined length of the head of any given internal punch and the proper knockout bar for use in the Mega-Mite press is always the same. This means if you have a die that comes with a punch using a short head length, you would use it with a tall knockout bar, and the combined length of the punch head and knockout bar would be the same as if you used a die with a long punch head and a matching short knockout bar. A set of knockout bars comes with the Mega-Mite press. One knockout bar comes with the Hydro-press That is all you need since the ram bottom position is adjustable.

All of the -H type Corbin presses come with a FPH-1-H Floating Punch Holder. This is a 1-1/2 by 12 tpi threaded cylinder about six inches long, with a knurled head at one end and a threaded recess or cavity at the other, which is fitted with a threaded bushing. The punch holder is used to position and secure the external punch in each swage die set. All swage dies have an internal punch, which rests on a shelf inside the press ram and remains internal to the die during operation, and an external punch which fits the punch holder in the top of the press, and comes in and out of the die for loading and ejection of the components.

The FPH-1-H Floating Punch Holder is adjusted up or down to increase the projection of the punch into the die, once the top sensor has established a “top of stroke” reference point. Moving the top sensor and turning the punch holder both have a similar affect, in that the position of the die relative to the tip of the punch is changed. This changes the amount of force applied to the parts inside the die, up to the limit established by the ram drive pressure and the breaking point of the die itself. The best way to set the top of stroke position is to find the lowest setting of the top position sensor that will let you easily remove and insert components into the die. Any higher setting just wastes times, because you are moving the ram further than necessary on each stroke.

Once you have set a top of stroke position, then you can put the external punch into the punch holder, adjust the punch holder one or two turns into the threads (very high in the press) and run the ram with the die and your component inserted to the top of the stroke. The punch should not yet contact the component. It may not enter the die yet, in fact. With the ram at the top of the stroke, turn the floating punch holder so that the punch is brought into the die and eventually contacts the component within the die. You will be able to tell, because you can't turn the punch holder by hand past the point of contact.

Once you have found the point of contact, lower the ram slightly, and give the punch holder another quarter turn lower (punch closer to the die). With the pressure set at a level just high enough to move the ram smoothly, but far below the maximum for the particular diameter of die, raise the ram again. Then lower the ram far enough to eject the part, and observe it. If the part is properly formed, the press is set up correctly. If the part is not formed, either the pressure is not high enough to flow the material any further, or else the position of the external punch is too high to push the component any further into the die.

If the gauge continues to read pressure and the red LED is not turned on, even though the press ram is as high as it can go, it means that the punch is contacting the component and the pressure is not high enough to cause the component to flow any further. This also happens when the component completely fills the die and there is no more room for expansion (assuming the die does not have bleed holes to let lead spurt out). But if the component is not formed completely, such as having an uneven diameter in the shank or cylinder portion of a bullet or having an incompletely filled-out nose, then you know that there is room for more expansion. Increasing the pressure (within safe limits) should cause the component to continue to fill the available space in the die.

Assuming you know the maximum safe pressure for the die (look it up in this book or calculate it with DC-DIES software), and the gauge pressure is below this level, you can slightly increase the pressure (say, by 100 pounds) and see if the component forms any further. Eventually the component will take on the shape of the die, and then no further change is necessary or desirable (using more pressure only stresses the die without affecting the component).

If the red LED does come on, and the gage pressure does drop to zero, yet the component is not properly sized or filled out, it simply means you need to lower the punch holder further, because the ram has gone as far as it can and lack of pressure isn't keeping it from going any further. So lower the ram slightly, lower the punch holder another quarter of a turn, and raise the ram again. Eventually you'll hit a point where the part forms perfectly, or else the ram stalls below the point where it can reach the top sensor (a stalled ram simply means that the resistance of the part to forming is equal to or greater than the drive force, and the ram cannot advance even though oil pressure is being supplied to it).

Stalling the ram is not a harmful condition, provided you do not leave it running in stalled condition for several minutes, which causes excessive oil heating. When the ram stops moving with power still applied to the drive cylinder, the oil is held at the gage pressure and surplus oil is pumped back into the tank through a bypass valve. There are two bypass valves. One is the drive pressure set control connected to the knob on top of the cabinet. The other is a valve built into the pump system and accessible only with a screwdriver, through a port on the back of the oil reservoir. This second valve is the safety bypass pressure limiter, and should not be turned any higher than the factory setting of about 2,000 psi.

Voiding warranties lets everyone off the hook financially except for the person who turned the screw. Of course, for some people, any limitation is a challenge, even a pressure limitation designed for safety and long equipment life. For them, replacing expensive parts and working out payment plans with the hospital may be a rare form of entertainment. I believe I'd rather shoot a pistol match.

In any case, the oil pushes against a powerful spring inside the pressure limiter, and when it overcomes the spring force, it pushes the spring back, opening an orifice that lets the oil go back into the tank. The oil is forced at high pressure through the orifice, which of course generates frictional heating and warms up the oil. At low pressures, the amount of heating is low and the two 100 cfm cooling fans on the cabinet cool the oil sufficiently. At high pressures, the oil generates much higher heat in flowing through the valve, so that prolonged operation with the ram stalled will eventually bring the oil to too high a temperature. At very high temperatures, the oil may break down and will become thinner, leaking past the pump vanes and causing cavitation or air entrainment, which can be very hard on the pump and lead to its destruction. So, try not to maintain a stalled condition for any longer than necessary, but don't worry about two or three minutes. Worry about ten or fifteen minutes, and become overburdened with angst at half an hour.

We've covered the main points of setup of the press. Now let's turn our attention to the pressure sensing system and see how to adjust the auto pressure set knob.

CHP-1 Hydro-Press™ Pressure Control

The CHP-1 drive pressure adjustment (PRESSURE SET) establishes the maximum pressure that will be applied. The AUTO PRESSURE SET knob controls the transducer pressure logic: a built-in pressure transducer monitors the pressure you are producing and activates a hold and reverse sequence when and if you reach a preset level.

The advantage is that you can back up your position setting by having the position come first and then, only if there is a failure to reverse, let the system pressure reverse the ram. But even more important is the simulation of skill, swaging by “feel”, that the transducer control provides.

Swaging by “feel” means that you push the core into the jacket until you feel a certain resistance on the handle of a mechanical press. Experienced bullet makers may scorn any kind of mechanical stop, because they know they can tell precisely if the core is too long, too short, the jacket too thick, or too thin, just by how the core seating “feels”. This is just another way of saying that you are swaging by pressure limit rather than position limit.

On the other hand, this sense of “feel” is subject to personal variations. It is subjective, not easily measured and controlled. A person may not realize when he is starting to get a little tired, and his arm just doesn’t respond the same way to the same pressure. The transducer never tires. It signals every time at the same pressure level.

Of course, there are tolerances in every kind of instrument. The transducer has a tolerance band, too. But it is a much more narrow one than the human arm, and varies much less over a day, a month, or several years.

When the system pressure is set higher than the level of the transducer, then and only then is it possible for the transducer to send its control signal to the logic circuits and reverse the ram at a given pressure. Obviously, if the system pressure limit has been set at 500 psi and you set the transducer to reverse the ram at 1000 psi, it won’t ever happen.

So, the first thing to realize is that the PRESSURE SET knob controls maximum pressure possible, and the AUTO PRESSURE SET knob controls the automatic reversing only if you want to reverse below maximum possible pressure.

This will seem obvious when you have thought about it. So, the first thing to do is set maximum pressure. How? Look up the safe limit for the die you are using. Check your notes from the die-maker: often there will be suggestions with the die set, which go deeper or override the general instructions found in the books and tables. Core seating in normal jackets usually runs 200-500 psi, and core swaging normally runs just about the same. Heavier jackets can run the pressure up to 800-1000 psi. But don't exceed die limits for the caliber!

A good way to start is to set the pressure at minimum (about 100-200 psi) and try to form the part or seat the core. If it forms to correct diameter, fine. If not, increase the PRESSURE SET knob a little at a time until it does or until you reach the maximum safe level.

While doing this, make sure that you are not being stopped short of forming the part by the top position sensor or by the end of physical travel of the cylinder. If the light on the side of the electronic position sensor comes on and the part still isn't formed correctly, most likely the sensor is too low or the position of the floating punch holder is not low enough. I like to set up the sensor for a comfortable stroke length, and then do the actual adjustment with the punch holder.

When you form the part nicely, set the pressure up another fifty to one hundred psi, and then adjust the AUTO PRESSURE SET knob to reverse the ram at the correct pressure. For the automatic pressure reversing system to have any effect, the PRESSURE switch must be on. Otherwise, the transducer is not connected to the logic circuit. Turning its knob does not affect anything.

If you adjust the AUTO PRESSURE SET too low, the ram will oscillate and chatter. This is caused by the sensor being set for reversal at the same level as the system resistance. Moving the ram generates a signal to reverse it. Increase the setting until the ram does not chatter. Experiment with the setting of the AUTO PRESSURE SET by using the physical limit of ram travel as your "bullet".

If you run the ram all the way up, with the top sensor out of the way, you'll stall the ram at the PRESSURE SET level. If you turn on the PRESSURE switch and hold down the ENERGIZE and UP buttons, one of two things will happen. Either the ram will continue to strain against its limit and the gage will show some reading, or the yellow light will come on and the gage will show no pressure.

If the gage continues to show pressure, and the yellow light does not come on, then it means your AUTO PRESSURE SET level is HIGHER than the system pressure. Turn the knob slowly until the yellow light will come on when you press the ENERGIZE and UP buttons. Now, you have set the AUTO PRESSURE SET level at or lower than maximum system pressure, and it will work.

To fine tune the exact pressure you want, set the system pressure where you want the reversal to occur, and then adjust the transducer setting until reversal occurs at that point. Then, increase the system pressure by fifty to one hundred pounds.

You can always do this with the end of the stroke, at the top. You can't do it at the bottom, since the transducer pressure always causes the ram do to down. If it is already down, nothing will happen when the transducer sends its signal.

Now, there are FOUR possible ways to stop the press ram on its upward travel. They are:

1. Stall the ram at system pressure (resistance equals force).
2. Reach the top sensor position (stop by position).
3. Reach the physical cylinder limit (run out of stroke).
4. Reach the auto pressure set level (stop by pressure).

The first will occur whenever the resistance met by the ram equals system pressure. You can increase the PRESSURE SET knob until you reach about 2,000 psi. Then the internal safety bypass will open. At 2,000 psi the top panel control ceases to have any more effect.

The second occurs when the ram moves up to the height of the top sensor. You can fine tune the exact amount of compression of your materials by adjusting the punch holder up and down at this point. It isn't necessary to move the top sensor, but you can. An adjuster mechanism with a scale is provided to make fine adjustment easier. The top sensor should be mounted so that you can slide it with gentle hand pressure. All the position sensors have a threaded cylindrical body. They slide up and down within an upright "standard", and can be locked in position by securing a nut on each sensor.

The cylinder limit normally is not reached in actual swaging operations, but is primarily used for setting drive pressure. It is safe to run the system against its own limits, even at 2,000 psi. But coming up against the end of the cylinder travel limit means none of your other limits have any effect (except pressure reversing) because the ram can't reach them.

The auto pressure set level will reverse the ram only if it is set lower than system pressure, and none of the other things happen first. You can tell if the ram reverses by position because the red light on the top sensor will come on. If it doesn't, and still the yellow down light comes on, then the pressure level is reversing the press ram. Switching OFF the PRESSURE toggle switch will disable pressure reversing, and you can tell immediately if it had been in control.

Experiment with the settings. Remember that the minimum pressure you can use is just higher than the resistance developed by the system inertia and oil flow. If normal movement generates enough pressure to trip the auto pressure reverse, the ram will chatter and oscillate. This will happen in the 100 psi to 500 psi range. The cure is to use a slightly higher auto pressure set level.

Corbin's Hydro-Mite (which uses -S dies) does not have automatic pressure reversing transducers. It is adjusted by setting the floating punch holder carefully, ever closer to the ram, in very small increments, and then running the ram up and down to see if it forms the bullet.

By checking carefully and slowly during the setup stage, you can adjust the position of the punch holder exactly right for your bullet without exceeding the die pressure for the caliber. A pressure gage is provided on the drive cylinder of all Corbin hydraulic presses. The main advantage of hydraulics on the smaller presses is to apply power for the full stroke length and make the operation less tiring for long runs. Jacket making and drawing operations are easier with a hydraulic system, since it develops constant power even at the start of the stroke.

The pressure gage on Corbin hydraulic presses is a high-quality glycerine-filled device. The clear lens will have liquid behind it, and generally has an air bubble floating near the top or center of the face on horizontal mounted gages. People who are not familiar with pressure gages sometimes call to say that their gage is broken or leaking inside.

The liquid is not hydraulic fluid. There is no physical path between the fluid in the hydraulic system and the inside of the gage (under the lens). The purpose of the glycerine is to act as a vibration damper, so that pump vibration transmitted through the lines will not jiggle the needle and make it hard to read. Cheap pressure gages have no liquid filling . They are harder to read, and will fail sooner from constant wear on the gears caused by vibration.

The air bubble is to allow for expansion of the liquid as the ambient temperature rises. If the bubble were not there, it is possible that the expanding liquid might break the lens, instead of compressing the bubble. The gage reads beyond 2000 psi because it is good engineering to use a gage with at least 25 percent greater capacity than the system pressure limit. A pressure gage which is reading its limit is also on the verge of breakage as its internal coiled tube uncoils to drive the gears which deflect the needle.

I have sometimes been asked why the press could not be built with multiple swaging position, so that several steps could be done at once. A multiple-head press could be built, but bear in mind the extreme pressures and forces needed just for good bullet making with a single head, and you will see that the cost would be considerably higher for such a press even without considering the other problems.

Each step in swaging may depend on a different criteria for correct completion. Core swaging is done by distance only, with a fixed end position, to assure consistent core weights. Core seating is best done by pressure, rather than distance, to provide exact expansion and diameter control. Point forming and lead tip forming each require setting to a specific distance or insertion of the external punch. If all operations were connected to one moving ram, then the best end point for each would be a compromise.

If the core swaging operation needed 200 psi and the point forming step required 1000 psi, a multiple-head system would also need multiple cylinders and multiple controls. One may as well buy three or four presses. It would provide the security of being able to use any of them for the same step, and one could interchange them in case of a problem.

I think that the question really was meant to be, “Why can’t the press be a progressive multistage machine that automatically feeds the bullet parts from one die to the next?”

That is called a “transfer press” or an “eyelet press”, which we talked about in an earlier chapter. Hydraulic power could be used to drive such a press instead of the usual flywheel drive. But the cost would still be in the five or six figure range, instead of only four figures, and the versatility drops to almost nothing with a given component feed system. Reliable feeding and handling of components is done cheaply by using your fingers, which can grasp almost anything and turn it in the right direction at any time. To replace your hand and mind with a machine means either spending tremendous amounts of money to get some ability to handle different calibers and shapes, or else just a great deal of money to handle one well.

As with many things in life, what is possible may not always fall within the economic range for a given market. The custom bullet field is not a high volume field that would reward an investment in single-purpose, dedicated high volume production tools. Mass market bullets are made on precisely this kind of machinery, and they are mass market because it is impractical to make them to order for small purchases.

The purpose of custom bullet making is to supplement, not replace, mass marketing. Mass-production firms recognize that custom bullet makers can supply the relatively smaller quantities of specialty bullets better than they do: they often purchase bullets from my clients for special purpose markets.

Custom bullets are loaded in top-end offerings from old line ammunition makers. At some point, the volume of sales may push a given custom bullet into the mass market field. At that point, the big step in investment may be necessary, to get high volume production equipment. But until that happens, there is really not much point in buying volume tools for a low volume market.

CHP-1 Hydro-press™ Operation

Designed with the home environment in mind, the CHP-1 operates from standard 115 volt 60-Hz power (U.S.A. standard version; a 205 to 250 volt 50/60-Hz option is available for export models), and is entirely self-contained in a steel cabinet. Access is controlled with a key switch. The machine can be locked off, locked in a manual-only mode, or put into automatic stroke mode with the same key.

Weighing 350 pounds, it can be moved by two people. It takes up about the same space as a typical bedside night-stand or end table, and looks somewhat like a small refrigerator with a colorful control panel on top. The dimensions are 34 inches tall, 22 inches wide, and 15 inches deep (cabinet size), with the press head itself extending another foot and a half above the top.

Inside the cabinet, you'll find a hydraulic reservoir that holds about five gallons of AW-46 fluid (available from Corbin in 1-gallon containers, catalog number CHF-1). It is seldom necessary to check inside the cabinet.

The oil temperature normally runs below 140 degrees (F.). If the temperature of the oil goes above this level, something unusual is happening: either the oil level is too low, the cooling fans or vent is blocked, or the ambient temperature is simply too high. If you can't do anything about the ambient temperature, then an alternative is to cycle the machine a little more slowly, reduce the time during which the pressure is held on a component, or increase the speed of ram travel (since slowing it down heats the oil). If you have an infrared sensing thermometer, take a reading from the lower portion of the cabinet, which is the oil reservoir, to get a good idea of oil temperature.

In all but the hottest climates and most unusual operating conditions, you won't have to worry about oil temperature, nor oil level. The system is closed, with a vertical cylinder. This eliminates side drag on the cylinder seals, which is a major cause of oil leakage in hydraulic systems. The high quality industrial cylinder utilized in the CHP-1 assures years of continual operation.

On top of the rectangular reservoir, which is the lower third of the cabinet itself, is the drive motor, a 1.5-horsepower fan-cooled 120/240 volt vertical unit. Mounted on the reservoir top beside the motor is the spool valve assembly, which consists of a precision-machined sub-plate with the patterns for oil flow drilled in a complex maze within it, and a precision valve assembly mounted on top.

The valve assembly, or solenoid valve, has a spool with machined grooves that match the four holes in the sub-plate. Depending on whether the left, right, or neither solenoid is energized, the spool will move to one of three positions, and thus permits three different patterns of oil flow through the holes in the sub-plate.

The pump itself is located inside the reservoir, along with an oil strainer and pickup tube. The pump has two separate sets of vanes moving in two chambers. A pressure-sensing valve connects them to the pressure lines. When the pressure is below a certain level, usually set for 500 psi, the larger pump operates in parallel with the smaller one, both moving oil at high volume and low pressure into the lines.

This moves the cylinder up quickly into position and retracts it quickly. When the punch and die come together and resistance is met (by pressing on the bullet), the pressure-sensing valve switches all the drive power to the smaller displacement pump, which then moves far less oil per minute but at a much higher pressure.

In this way, you can have the same effect as if you were running a much larger motor. You get both speed and power, apparently at the same time but actually only when each is called for. To do this with one pump would require not only a much larger and more costly machine, but also three-phase 220/440 volt electric service (not available in most residential areas). The time-shared or multiplexed pump system lets you run the Corbin Hydro-press on less power, and makes the whole package much more effective for less money and size.

The valve can be removed without disconnecting any plumbing. It bolts straight down on top of the sub-plate. There are four O-ring seals, one over each of the holes in the sub-plate, and these match the valve body. In the unlikely event that a valve would fail, it is a fairly simple matter to replace it. Four wires connect the two solenoids to the controls, in two pair. One pair connects to the “up” solenoid, and one to the “down” solenoid. The connections within each pair are interchangeable (no polarity) but the pair must be connected to the correct solenoid. Therefore, when replacing the valve, be certain to tag the wires so that you know how to reconnect them.

The drive cylinder is mounted in the left rear quarter of the cabinet by four steel rods. Its massive shaft is coupled to a hardened steel ram, which is replaceable separately from the cylinder. The ram is aligned by an inch-thick guide plate holds the upper end steady between the two hardened and polished guide rods that support the press head. Two more bearings slide over these guide rods to align the guide plate.

Connected between the two cylinder oil lines and the valve are the top panel pressure adjustment, the ram velocity adjustment, the oil pressure gage, and the oil pressure transducer (with adjustable trip level reversing switch). All the adjustments are operator-controlled with knobs on the top panel. You do not have to open the cabinet, and can set them quickly as you operate the press.

One of the major advantages of this machine over hand presses or brute-force presses is the logic and control system. Located in the upper middle, near the top of the cabinet, is a sub-panel with the logic relays and terminal connections to a set of three electronic position sensors (non-contact RF field-effect type).

The position sensors (proximity detectors) are located on a steel standard that projects alongside the press head. They sense the position of the ram and tell the logic system when it reaches the top, bottom, or loading position in its stroke. By moving the sensors, you can set the press stroke anywhere you wish, from a couple of inches to a full six inches of travel.

The top of stroke, bottom of stroke, and loading stop are all adjustable, unlike a mechanical press or a simple hydraulic system. This means you can optimize the system in seconds for any given job or set of dies and punches. You don’t have to waste time on a long stroke if you are making pistol bullets, and you are not limited to contortions in getting a long .50 caliber bullet in and out of the dies.

But more important is the fact that die and punch design can be much more versatile with such a press. The punch heads, die length, and bullet length are all critically matched. The ram is machined to support the punch at a certain point in its retraction from the die, so it won’t fall out of the die. And you can set the stroke so it stops at just the right point, ejecting the bullet cleanly and stopping the press, or ejecting and then moving back up to loading position.

The top of the stroke can be set so that you have plenty of room to place the bullet in the die mouth, under the punch, and enough time to watch the die rise up toward the punch and stop if anything appears misaligned. The actual point where pressure is developed in the die is set both by the position of the top sensor (which controls stroke length) and the relative position of the floating punch holder (which controls the punch insertion into the die at any given point along the stroke).

A fine-adjustment device holds the top sensor, so that you can fine-tune the top of stroke position for optimum results. Since there is no contact between the ram and the sensor, no physical stress is developed that could influence the setting. A typical position tolerance for the entire system might be 0.01-inches, using only the electronic position sensor to stop the stroke.

Although the sensor itself is capable of much finer precision, by the time you factor in changes in oil temperature and viscosity, inertia of the system, and speed of valve closures, plus a little drift in the final position for the ram, this would be a practical limit. Once the press has reached a stable oil temperature and assuming that ambient conditions are such that heat is removed at the same rate as it builds (thermal equilibrium), a maximum variation of as little as 0.005 inches may be achieved in the total 6-inch stroke.

In most operations, this would be more than sufficient precision (since this only controls the final tip closure of the bullet: the core seating operation is generally done by pressure rather than position). However, there are some operations where the tip shape can be influenced by very small changes in where the ram comes to rest. If you find a particular bullet design that seems to come out with too much variation in tip diameter or shape (especially lead tip bullets or hollow point pistol bullets), there is a special high-accuracy positive stop punch holder that will reduce the tolerance in ram position to only a few thousandths of an inch at most.

This special punch holder is machined to take the external punch through a cavity drilled all the way through the punch body. The punch is dropped in from the top, and then a hardened stop rod is screwed in behind it. This long threaded rod presses against the head of punch, which can slide up and down within the punch holder body. The punch holder itself is made of hardened and tempered tool steel. The face of the body is made to press against the face of the die and actually stop the press physically. Since the die face and punch holder face make contact, the punch protrusion into the die is set by the threaded rod. Instead of using the position sensor to stop the ram, you would use the pressure reversing system. The system pressure limit would be set higher than required to form the part, but still under the safe limit of the die. The top sensor would be moved above the point where the punch holder stops the ram movement (so it never comes on).

Now, when you form a bullet, the ram moves up until the die contacts the bottom of the punch holder, and is stopped by it. The punch holder adsorbs the entire force of the ram (which is why it must be made of hardened steel). The pressure rises to meet the resistance, until it reaches the trip point you have set for reversing the ram. A half second or more delay should be used (the dwell time knob can be set at a quarter turn from the normal position).

The position adjusting rod should be screwed out to nearly its maximum limit (a ring machined around the middle of the rod marks the point where no further threads should be seen above the top of the punch holder, as this would leave too few threads to safely hold the ram force). Then, it is screwed down while you inspect the bullet between strokes, and locked in position when you achieve the desired shape. This kind of punch holder is not required for most operations, but for critical ones, it can prove most beneficial. It is an optional part, FPH-2-H, not included with the standard package.

A third kind of special punch holder is the FPH-H-QC quick change punch holder. This punch holder is slotted to allow sideways insertion of the external punch, and it has an adjustable threaded rod which sets the sliding fit tolerance against the top of the punch head. The purpose is to allow the operator to quickly remove and insert the external punch during operation, so that it can be changed for fast multiple operations on the same part, or so that very long parts can be loaded and removed without having to adjust the position of the punch holder on each stroke. One example would be forming very long tubing jackets in a 50 caliber or 20mm size. Another might be forming a hollow point cavity and immediately reforming the bullet nose with a round nose punch without ejecting it from the die.

The CHP-1 top panel catches the eye immediately with its large, colorful control buttons. Three oversized buttons are used for ram motion control. At the left is a large green button labeled “ENERGIZE”. This button is operated with the left hand. On the right side of the press are two buttons labeled “UP” and “DOWN”.

To move the ram, you have to have your left hand on the "ENERGIZE" button, and your right hand on the "UP" or "DOWN" button. On the upward stroke, the ram will stop immediately if you lift either hand. On the down stroke, you can start the ram down manually at any time, then use your right hand to remove and load another component while the ram finishes moving down.

The key switch marked "OFF", "ON", and "AUTO", controls power to the logic and motor circuits. In the OFF position, only the inspection lamp and the cooling fans will operate. In the ON position, you have manual control over the press by using the push-buttons (the press will not actually come "on" until you turn the pump switch on, however, so you can remove the key in the ON position and thus lock the machine in a manual mode while still giving the operator control over the ON / OFF switch via the pump control).

In the AUTO position, a red light near the key switch comes on, indicating that the press CAN be run in the automatic mode now. Whenever the red light is on, be aware that entering a certain sequence of button presses will start the press and cause it to cycle through whatever programmed steps you have set up, even if you lift your hands from the buttons.

The sequence of steps to start an automatic cycle follows:

1. Press and hold down the ENERGIZE button
2. Press and hold down the UP button
3. Release the UP button
4. Release the ENERGIZE button

If you do this any other way, the press will stop when you lift one hand or the other, even though it is in the auto mode. This is to help prevent accidental start-up as a result of leaning on the buttons.

There are four switches on the right side of the top panel. The one labeled "PUMP" turns the hydraulic pump motor on and off. This switch gets its power from the key switch, so locking the key switch off effectively shuts down and disables the pump switch. The pump switch is also a 20-ampere circuit breaker, which will trip if the pump motor draws too much current.

The next switch under this is labeled “POSITION”. This switch controls what happens when the press ram reaches the height set by the top sensor. If you turn this switch off, the press will simply come to a stop, and hold at the top position. You can manually retract the ram by pressing the ENERGIZE and DOWN buttons (green and yellow).

If you turn the position switch on, the ram will move up (when you press the ENERGIZE and UP buttons) until it reaches the height of the top sensor, or the end of the cylinder stroke. If the top sensor is reached, a yellow light will come on, indicating that the logic and timing circuits are in control and counting seconds until pressure has been held as long as the adjustable delay timer determines. (You can set this delay time from about 0.1 seconds to 10 seconds by means of a knob at the rear center of the top panel.)

When the time delay has passed, the ram will begin to move down by itself. You can lift your hand from the red UP button now, and the ram will still move down until it reaches the height of the bottom position sensor. (If you have set the bottom sensor too low, the ram will go down until it reaches the physical limit of its travel, and the pump will continue to hold whatever pressure you have set.)

The advantage of automatic reversal by position is that you can precisely control the exact amount of insertion of the component into the die by length, the amount of time the pressure will be held on the component, and you will have one hand free to pick the part off the top of the die when it ejects.

The next switch is labeled “PRESSURE”. It controls the effect of the automatic pressure reversing transducer. When this switch is off, pressure has no effect on the maximum height the ram will reach (other than the fact that the ram will move until the pressure you have set matches the resistance met by the ram as it pushes the punch against your bullet components).

When the switch is on, the pressure transducer will send a signal to the logic circuits to reverse the ram as soon as the pressure you have dialed in to the “AUTO-PRESSURE SET” knob is reached. The yellow light will come on, the delay will time out, and the ram will go down regardless of whether the ram ever reached the top sensor.

This feature enables you to duplicate the effect of “seating by feel”, except that you can use precise pressure levels instead of the inexact “feel” on the handle of a mechanical press. The combination of automatic stop and hold, then reverse, by means of either position or pressure in the die gives you a tremendous amount of control for making consistent bullets.

It also gives you a backup method of protecting your dies. In this book, you will find tables of pressure limits for each bore size of die used in the Corbin CHP-1. If you adjust the “PRESSURE SET” knob so that the maximum possible pressure is less than this level, you can’t break the die. Then, if you set the automatic “AUTO PRESSURE SET” knob for a pressure slightly less than this, the ram will reverse before it ever gets to the maximum you have set. Finally, if you adjust the top sensor so that the ram will be stopped before it is able to push beyond the desired insertion depth in the die, and turn on the POSITION switch, you’ll have triple protection against damage.

The last switch in the row on the right side of the panel is the one labeled “LOAD POS.” which stands for loading position. If you turn this switch on, the ram will move to the top when you press ENERGIZE and UP, and do whatever you have programmed with the POSITION and PRESSURE switches. Then, it will go down until it reaches the bottom sensor height. If you hold the UP button depressed during the entire cycle, the ram will reverse when it reaches the bottom position, and start up again. A dwell timer on presses built since 2003 controls the length of time that the press will wait until starting up again. When it reaches the height of the middle position sensor (load position), it will stop and will not go up again unless you first release both buttons and then press them both (ENERGIZE and UP) again.

The advantage of this is that you can have a completely automatic one-cycle operation with safety. Both hands must be out of the way. The ram will go up, swage the bullet, hold the pressure for a certain time, reverse, come down and eject the bullet to the top of the die, wait until the bottom dwell timer times out, then raise up slightly so you can put a new bullet in the die without having to balance it on the end of the internal punch.

With the key switch in AUTO position, all these functions continue once you have released the ENERGIZE and UP buttons in the proper sequence. If the LOAD POS. switch is turned off, the ram will simply go up and down until you press and release the ENERGIZE button or override an up-stroke cycle by pressing the DOWN button.

But if the LOAD POS. switch is turned on in AUTO mode, the press will make a complete cycle by itself, then wait at the loading position for you to remove the bullet and insert another one. This is a handy way to operate the press, assuming that the operator is adult, responsible, and paying attention. The press won't stop if you put your hand in the way of the moving ram in AUTO mode. Never reach into the press head area with the ram moving.

A way to extract and insert components without danger to your hands is to use a pair of large industrial forceps or tweezers, or a long-nosed pair of pliers, to handle the components. Chances are that you will never come close to hurting yourself, because the ram moves relatively slow compared to a mechanical press, and you have a lot of time to see what is happening. But, play it safe. An accident can have permanent results.

The ENERGIZE button serves as an emergency stop in the AUTO mode. Press and release it to shut down all movement of the ram. The yellow DOWN button overrides any UP command from the logic circuits, but as soon as you release it, the ram will move in the direction it was going before. This can be used for "jogging" the ram up and down for certain jobs.

The PRESSURE SET and AUTO PRESSURE SET knobs were explained in a separate chapter. A brief recap may be useful here. PRESSURE SET controls the maximum possible system pressure. It is normally adjusted by moving the top sensor out of the way, turning off the PRESSURE switch, and running the ram to the top of the stroke in AUTO mode (or, by pressing and holding the ENERGIZE and UP buttons in manual mode).

Then, the PRESSURE SET knob is turned as the pump works against the end of the physical stroke limit. The cylinder is "stalled" against the end of its housing, and the ram can go no further. At this point, you can generate as much pressure as the system will stand, which is considerably more than the pump and motor will produce—in other words, there is no limit except for stalling the motor, and that is prevented by an internal limiter or bypass valve that opens and pumps oil to the tank in an endless do-nothing loop at approximately 2,000 psi gage pressure.

When the ram is stalled this way, you can produce anything from near zero to 2,000 psi by turning the PRESSURE SET knob. Bear in mind that if the top sensor is low enough on its standard to actually reach the maximum height of the ram, it will turn off the valve and you will get NO pressure reading no matter what you do with the knob. You have to move the top sensor out of the way. Turning it off simply stops the ram at the top by switching the oil control valve to the middle position (idle).

You can do the same thing at the bottom of the stroke. The bottom sensor must be moved low enough so that it cannot sense the lowest possible position of the ram. Then, you can adjust the system pressure by reading the gage as you turn the PRESSURE SET knob. Bear in mind that you are setting the maximum possible pressure with this knob, not the reversing pressure. If you set this knob for 1,000 psi on the gage, there is no possible way for the system to produce more than 1,000 psi under any circumstances.

On the other hand, if you forget to adjust this knob for a safe level for a given die, and then run the ram up with a component in the die, you will surely at some point break a die. The safest way to handle pressure setting is to back the knob off until you read nothing, then increase it only a small amount (perhaps 200 psi) or whatever is a minimum you can read.

It is normal for the system to show some pressure when the ram moves up and down, because this is the pressure caused by line and control resistances. When we say "zero" pressure, we really mean the normal minimum pressure while the ram is moving freely. Of course there must be some small pressure to move the ram.

While you have a component being pressed in the die, you can increase the pressure slowly and then eject the part to see how it is forming. At some point, a minimum pressure will be reached where the part actually forms correctly. If you are forming the part by pushing the components into a die to a certain distance, you will want to use somewhat more than the minimum required pressure, and then let the position sensor stop the ram. If you have a problem with unformed parts or variation in core weights, chances are you have the pressure set too low.

This must not be construed as a license to exceed the maximum safe pressure listing, however! If you still have any problems with weight variations or unformed noses on lead bullets and have reached the maximum safe pressure for the die, something else is wrong. Never exceed maximum safe die pressure listed in this book, or you will blow up your die. Only one thing does that: excess pressure. Only one person is responsible for it: the operator. A die, split in half, that is returned with a message saying "I don't know what happened.

I didn’t do anything different from the first five bullets, and then it just broke” is in two pieces because of excess pressure. Nothing else will do it.

Excess pressure can be withstood for a while, depending on just how excess it is. Just as you wouldn’t expect your gun to last very long if all you fired were proof loads, you probably should not expect the die to last very long if you make your bullets with a pressure that exceeds the die strength. You may get away with it five times, or a hundred times, but each time you apply excess pressure, you are stressing the die and affecting its ability to handle additional strain. In fact, it isn’t uncommon for someone to nearly but not quite crack a die, put it away, and a year later get it out and have it break on the first bullet made, even with normal pressure. The damage had already been done. The die was just hanging together, waiting for the last straw to break it. The last thing you do isn’t necessarily the thing that caused the problem. It may have been the previous history of the die that caused it to finally give up.

Having said that, my conscience is clear: if anyone still wants to disregard the pressure limits, it just means replacement die sales, so it won't upset anyone here! One of the pioneers of swaging, Ted Smith, used to joke that his instructions should read "Throw all your weight on the handle, remove the die you just ruined, and send it back along with a check for the replacement."

When a die blows up, it cracks. Usually it is loud, but it is rare for any pieces to fly. I would stop short of saying it is safe to crack a die. It is possible for a piece of the die to fly out, but I have never seen it happen in decades of bullet swaging and hundreds of blown-up dies (including a large number broken on purpose to test the pressure formulae for you, and make sure the charts are accurate).

A die that cracks because it is defective is so rare that it belongs in the Smithsonian. Defects might include incorrect heat treatment or a seam in the actual bar of steel from which the die was made, but they generally show up during lapping, honing, or testing. A grey, fine crystalline structure on the broken surface is indicative of excess pressure. The steel doesn't "crystallize" because it is defective (I hear that one every so often, too).

Punches, however, can be driven too quickly with incorrectly sized or inserted components in the die (or, in the case of a draw die, on the punch), and they may strike the die face, bend, and snap off. The parts of the punch can fly a good distance with some energy.

Whenever you are using a drawing die in the press head, with a long thin draw punch in the press ram, be extra careful to make certain the parts you are drawing are correctly aligned and that the die and punch are in fact made for the wall thickness and diameter of part you are attempting to draw.

One particular example of forcing a punch off to one side so it strikes the die mouth is the use of a hollow point or hollow base punch with a cut lead core. Lead wire normally cuts with a double shear angle. The ends of the cut wire have an off-center wedge shape. The small pointed end of a hollow point or hollow base forming punch will be pushed down one of these sloped cut angles and drive the punch to one side. The solution is to first swage the cut lead with a flat end punch, and then follow up with the hollow point punch in a second operation. Either that, or make certain that the length of lead you are swaging is short enough so that the hollow point punch can align itself at least one full caliber inside the die before it encounters the lead.

In many cases, damaged punches and chipped die mouths are a result of using much too long a component in the die. With any swage die, the external punch should encounter no resistance until it has entered and aligned itself with the die cavity. A distance of at least one caliber (or diameter of the punch) is the minimum necessary to keep the punch from being driven to one side by eccentric core ends.

The second most common cause of damage to punches is using the wrong punch for the operation (or the wrong size of punch). Try the punch by hand. It may enter the die snugly with a little twisting effort in some cases, but it should enter. Core seating punches need to fit the inside diameter of the particular jacket you are using, at the particular length of core you want to seat. Because many jackets have tapered walls that grow thicker toward the base, making a light bullet may require a smaller diameter core seating punch than a heavier bullet in the same jacket. Fortunately, this seldom breaks anything. The usual symptom is an undersized bullet, such as a .308 die set producing a .3075 bullet. Changing the jacket, the core weight, or the punch to a proper diameter brings the diameter back.

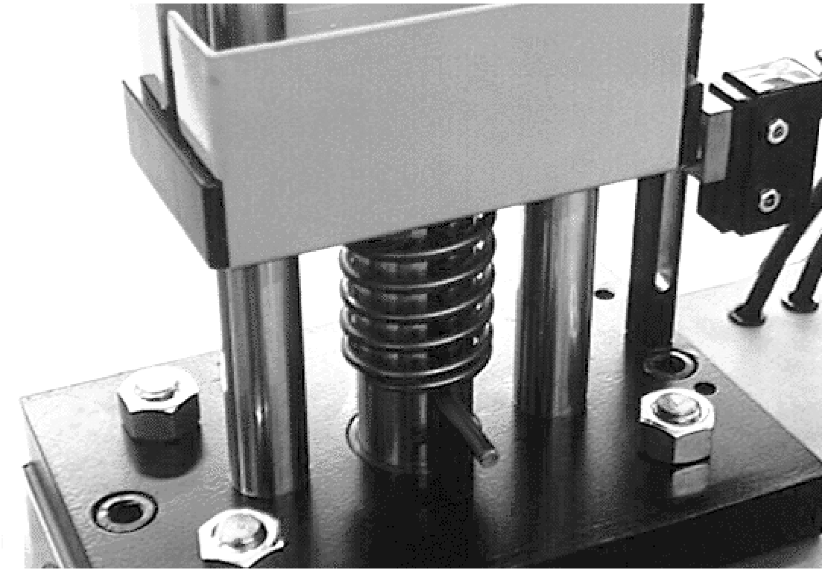
Two orange guards of heavy sheet metal that accompany each CHP-1 press. They are for your protection. They slip onto the moving guide plate, one for the back and one in front. They don't get in your way while using the die, and they are only marginally in the way when you unscrew a die, since you can easily reach over them.

The purpose of these guards isn't to keep your hands out of the way. It is to stop lead extrusions or pieces of broken die from flying out and causing injury. When extruding hard lead alloys, the pressure builds up inside the die to a much greater extent than it does with soft lead cores. Swaging a hard core causes the pressure to build until it cracks the core extrusion wire away from the main body of the core, and then the little extruded piece of the core will fly out from the three bleed holes in the core swage die at rather high speed.

The metal guards stop the extrusions safely. If you install them correctly (closer to the left side than the right side of the guide plate), the top position sensor will not "see" the guard. If you get them too close to the right edge, it might be possible for the sensor to "see" the guard and stop the ram short of its correct position. The same thing can occur if you let lots of lead wire extrusions build up on the top of the moving guide plate. One or more of them might be right in the path used by the top proximity sensor. It can sense lead as well as any other metal.

Some bullet makers remove these guards and operate without them. It is not a smart thing to do. The CHP-1 is an industrial machine built for business, not for the general public. A person in business is expected to act a little more responsibly than someone who walks in off the street. Part of that responsibility is in recognizing that the manufacturer of a machine of this nature can only go so far in providing protection against operator errors. If the operator puts himself in greater danger by disabling or misusing the very features that were designed to protect him, then any problems he makes for himself are his own responsibility.

The CHP-1 is vastly more powerful than any other device used by handloaders and bullet makers, but it is also designed to be safe to operate. Lighted indicators, color-coded controls, key-locked modes, totally-enclosed hydraulic and electrical system, guards where experience has shown them to be necessary, and two-hand operation in normal mode, all combine to make the CHP-1 a pleasure to use without the level of concern for a moment's inattention associated with a punch press.



Power Jacket-Making

Having full power available from top to bottom of the stroke is a major advantage of the Hydro-press for jacket making. The relatively slow, steady ram travel of a hydraulic system allows simplified forming operations that would not be practical with a high impact velocity punch press. Gentle impact and slower deformation of the work material helps prevent tearing and breaking through on deep draws, as well as allowing the use of softer alloys and metals than are easily fed at high speed through a transfer press.

There are four primary ways of making bullet jackets. First, you can start with strip metal—flat stock—and punch out a disc, then cup and draw this disc into a jacket in several steps. This method is commonly used in transfer presses by the major bullet makers, with the exception of Nosler.

Some of the Nosler bullets are formed by impact extrusion. A solid wire of copper or gilding metal is fed into a die, where a piece is cut off. The piece of solid wire is struck by a punch to extrude metal around the punch, forming a cup. The stresses involved are very high, and the design of the punch, dies, and press itself including the stripper mechanism to remove the part from the punch precludes using this method for low-cost home-based operations.

You can form jackets without extreme expense by using either pre-drawn cups or tubing. In the case of the cups, there are three ways to get them.

1. You can purchase an existing pistol or rifle jacket that is too large in diameter, and draw it down, then pinch-trim it to length.
2. You can drill a piece of solid rod and then swage it to gain the necessary concentricity and precision.
3. You can use flat stock like the factories do, with Corbin's jacket making kits and coil handling machines.

Drawn jackets can be made of gilding metal, copper, brass, aluminum, or even mild steel. Our recommended material for most hunting bullets is deep-drawing grade pure copper strip. For high precision target bullets (primarily rifle calibers), we might shift to a 5 to 10 percent zinc / copper alloy such as gilding metal or commercial bronze (a misnomer, but commonly used in the trade). But with the right tools, benchrest grade jackets can be drawn from pure copper strip.

Up to half-inch length pistol cups can be made using any Corbin hand press and a simple four-die kit (blank, cup, draw, and redraw / trim). For longer jackets, Corbin makes both manual and semi-auto kits for the Hydro-press. Manual jacket making kits require that you feed the flat strip (usually from 1-inch to 1.25-inches in width, and from 0.03 to 0.05 inches thick) through the first stage by hand. The first stage cuts a disc (blanks) which is sometimes called a “coin”. The coin is placed in a cupping die, which draws a shallow cup (cups) in one stroke. In the semiautomatic kit, the blanking and cupping operations are combined with a coil feeding system, so that cups are produced while the operator watches, directly from a fifty to one hundred pound coil of strip.

The manual feed JMK-1-H die set does not require a decoiler to handle feeding of strip. The automatic feed JMK-2-H die set does. It is sold separately because some people have access to existing decoilers. The Corbin Strip Uncoiler or CSU-1 is designed to provide automatic demand feed with used with the Hydro-press. The JMK-2-H also includes a different head assembly for the press, with an automatic shut-off that turns off the press when the strip runs out. You can’t walk away and leave it running for safety reasons, but essentially the blanking and cupping operation is a hands-free automatic process. It includes lubrication and separation of the scrap and cups.

The cups are considerably shorter and larger in diameter than the desired jacket. They also have much thicker walls. For example, a 1.25 inch long .308 caliber jacket with .015-.025 tapered walls might require a beginning strip of 1.25 inch width with a thickness of .030 inches, and the starting cup might be nearly straight walled with close to .028 walls that are only 0.5 inches high. The edges of the cup are not absolutely even. They are trimmed to perfect evenness in the final stage, after redrawing two or three times.

The semi-auto kits save you money by using a special head and feeder that goes on the Hydro-press instead of using a special jacket-making machine. But there is no further automation. To process the cups into longer jackets, and trim them evenly, you must feed them in the next one to three stages by hand. The cost of alignment and insertion tooling to automate handling typically exceeds the cost of everything else several times. It certainly can be done. But in the custom bullet field, it may not be a wise use of funds.

Corbin's breakthrough designs have made it practical for very small businesses to produce high quality jackets with less than a tenth of the investment normally required. The tooling is designed for one specific jacket, but you can draw smaller calibers and shorter jackets using additional draw and trim dies. The final trim die is adjustable from the maximum design length to shorter lengths.

There are usually additional jackets that can be drawn from the initial cup, or perhaps from one of the intermediate drawing stages, with other dies. Every additional jacket requires some development of tooling, and is limited by the volume of material present in the initial cup. You can’t make a 50 caliber jacket by adding a few different dies to a set designed to produce .22 jackets, for instance. That much is probably obvious. But what may not be quite as obvious without some development work is whether you could get a .270 caliber jacket with 1-inch length by adding any dies to a set designed to make a half-inch long .50 pistol jacket. Maybe you could. I wouldn’t know until we had first worked out the feasibility (the math, on paper) and then tried building some prototypes (the research and development stage).

Often people ask me to quote the most economical package for a wide range of jackets, and they specify the lengths and wall thickness as well as caliber. Sometimes several calibers can be made from one basic jacket making kit by adding additional dies and punches, but in order to use the same starting material and cupping dies, only certain combinations of length, caliber, and wall thickness might be possible.

Any jacket you want can be drawn, as far as caliber, length, and wall thickness, but it might require a complete jacket maker kit and different strip dimensions for some of them. There are some basic physics that cannot be ignored, when it comes to the total volume of material that can be obtained from a circle cut out of a given width and thickness of strip. Normally, I will quote a price for a package of dies that I know will work, even if later we find that some of the parts are not necessary. It is much more pleasant to inform a client that the package will cost less than expected than it is to disappoint them when a speculative, possible way to cut corners did not work.

Another method of making jackets involves tubing. Copper, brass, or even steel tubing can be obtained in slightly larger diameter than required for the jacket. The first stage is to cut off pieces of the tubing, a job best done by a special tubing cutter saw. Corbin makes the SAW-1 power tubing saw to produce even, clean cuts on copper and brass tubing from 1/4-inch to 5/8-inch diameter, up to 3 inch lengths. You can also rig up a stop on your power bandsaw or table saw and purchase a fine tooth blade for it. The saws designed for cutting wood normally have the wrong blade speed for copper, but they will work moderately well. Copper is a “sticky” metal that should be cut with a zero or even slightly negative rake tooth, with enough teeth per inch so that two of them are within the wall thickness of the tubing at any moment. Another method of cutting copper tubing to length is to use a turret lathe or screw machine. The cut must be burr-free. The jacket weight will be controlled by the precision of the cut.

The next stage rounds one end of the tubing. The die for this job looks like a point forming die. It has a cavity shaped like a blunt bullet, and a small ejection pin at one end. A punch supports the inside of the jacket and has a shoulder that pushes on the opposite end. The punch tip must be shorter than the jacket length to be formed, so the end can be rolled around. Generally, about half the diameter of unsupported tube projects beyond the punch tip. Each length of jacket you wish to make requires one “end rounding” punch. An alternative is the adjustable length punch, which costs about three times as much to make as a solid punch. If you want two lengths of jacket, it is cheaper to get two solid punches. If you want three or more lengths, the adjustable punch makes good sense.

Pressing the tubing into the die rounds one end. It is then ejected from the die, and pushed through a reducing die to bring it below the diameter required for the bullet. The tubing is then annealed, using either a propane torch or an electric furnace (heat the jacket red and let it cool or quench in water to expedite the process—quenching has no effect on hardness, unlike tempering of steel). Using the regular core seating die for the desired caliber, a special punch goes into the jacket. This punch is called the “end flattening” punch, and looks like the end rounding punch, except that it is smaller in diameter and perhaps a bit longer. The end of the end flattening punch presses on the rounded bottom of the jacket and flattens it against the internal punch face.

If you wish to make a rebated boattail bullet jacket, the “end flattening” punch is replaced by one that looks more like the boattail itself. Instead of flattening the jacket end, it reshapes the jacket into a boattail form. The die used with this punch is the BT-1 boattail forming die. It is the same die that will be used to seat the core into the jacket.

Annealing is very important, since the tooling tolerances are close and the amount of springback in the material strongly affects how well the operations work. By annealing, a common point of reference between the material used by the die-maker in developing the set and the material used by the bullet maker is established. With some tubing, annealing may not be required. Tubing is interesting material to work with, and can vary widely from different sources in regard to alloy, grain structure, hardness, tolerances for diameter and wall thickness.

Corbin supplies high quality tubing for which we have years of development information. Using your sample tubing to develop a set of jacket making dies means developing the proper dimensions all over again, and requires considerably more production time. Therefore, it costs less to order tubing with the dies, and then find a local supplier later who can match the tubing specifications. If you wish to start with a readily available local supply of tubing, we will need at least six feet of it (which can be sent in 2-foot pieces to reduce shipping cost) before we can start developing your dies and the instructions for using them (which may be different from using our standard dies with our tubing).

Annealing the material helps prevent sticking, cracking, and wrinkling of the jacket. A normal anneal involves heating the jacket material to cherry red, then quenching in cold water to knock off any scale. At 1500 degrees (F.), the jacket is annealed very completely. Almost every problem that a person has with the proper copper tubing can be traced to failure to anneal the material. People just ignore this because they don't want to stop and do it. Big mistake.

Soft coiled tubing is already annealed. It seems to work just fine, with the possible exception of cutting it to length (can't be done in a lathe, as the soft material flops around like a string). If the coils are too tight, then you may have problems getting the tubing to fit over a punch because of the curvature. Straight lengths of hard drawn tubing are generally preferred to soft coiled tubing for mechanical reasons.

Tubing jackets can be formed from material as light as 0.025-inch thick in the walls, to as heavy as 0.125-inch thickness. Naturally, it would be silly to try to form a small caliber with a jacket so thick that it left only a pinhole for a cavity, unless one wanted a solid copper or brass bullet. Then, this is quite practical and works better than trying to use solid rod.

Tubing jackets can be formed with totally closed bases. Unlike those formed in hand presses, the jackets made in the Hydro-press can be gas-tight. The base thickness can be made several times the wall thickness, in fact. This is a function of the punch tip lengths used in the end-rounding and end-flattening steps.

Selective thickening can be done, although the exact amount will depend on material characteristics and is difficult to engineer beforehand. A jacket with a heavier section through the lower portion of the shank can be made by forming a normal jacket from tubing, then using a short lead core to provide partial support to the lower shank. A steel punch that fits snugly in the remaining length of the jacket is used. The punch has a shoulder that presses against the end of the jacket.

Being supported firmly by the steel punch tip, the jacket will tend to collapse upon itself below the punch, where lead supports the walls. If the lead provides enough support and the punch length is correct, the lower portion of the walls will thicken evenly. If anything is out of balance, the lower portion may collapse by folding upon itself unevenly. But once the design is worked out, the particular set will continue to produce good jackets so long as the material is not changed.

Partitioned bullet jackets can be made by a similar method. The tubing is cut to length, but it is made a little long (experimentally determined). Typically half a caliber extra length is allowed in most materials. The material is drawn down first, before any end closure is attempted.

It is annealed, and put into a straight core seating die with two special punches. The two punches have tips that fit inside the jacket tubing. They also have shoulders that fit closely to the die, and press against the ends of the tubing. Because the tubing is supported by the punch tips and is pressed on both ends by the shoulders, the only place it can move is to buckle inward between the two punch tips.

This happens, and then the punch tips come down against the fold. Under tons of pressure, the fold becomes a solid partition with a hole in the middle, the diameter of which depends on material thickness, caliber, and other characteristics. It is not practical to precisely design the hole diameter given the number of variables, but with 0.030 to 0.049 material in .30 to .375 calibers, it is possible to make a small closure. In nearly all cases the partition will become about twice as thick as the walls, and that alone is enough to stop expansion and retain the rear core.

With brass and steel, the partition is an experimental thing that may or may not work in any given combination of caliber, thickness, and length. With copper, it is possible to insure it will work with nearly all calibers and combinations to some degree. The quality of bullet that can be made this way is very high.

Copper tubing jackets can be thinned on the nose end for better expansion on light game, but there are some limits to the process. The most common way to handle this is to ream the inside of the tubing. If the reduction is from 0.125 to 0.035 or so, this is fine. But if the reduction is from 0.035 to 0.020 or something of this nature, then the strength of the jacket wall to resist the torque produced by the reamer not be sufficient. The torque produced by the reamer may destroy the jacket.

Also, the frail end of the jacket may not be sufficient to withstand the pressures required to form the base. In that case, the jacket must be formed first at full wall thickness, and the finished jacket then reamed part way to reduce walls. An easier way to do this would be to turn a taper on the outside of each jacket. When the core is seated, the internal pressure will push the jacket against the die walls and reverse the side on which the taper is formed.

In some cases it may be possible to produce a thinned front region on the jacket with a tapered punch in the core seating die. The copper tubing may be compressed against a tapered section of punch and extruded forward, thinning the walls. The tube may try to stick on the punch at this point, wedged against it under tons of pressure, so that removing the jacket from the punch might require grasping it with smooth-jawed pliers and turning it. Or a custom built extractor mechanism may be built to pull the jacket off the punch. Whether or not these measures are necessary depend on the geometry desired in the taper and the material itself.

A final limit to jacket thinning operations is the force necessary to push the jacket out of the point forming die. If the force required for ejection exceeds the strength of the tip, the bullet will stick in the die because the ejection pin will collapse the jacket or penetrate through the tip. These factors limit the usefulness of thinning jacket materials to increase expansion. Done with care and experimentation, the process can be perfected for a given caliber and style of bullet within those limitations.

On the top panel of the Hydro-press, you will find a speed control. This adjustment lets you set the ram travel from clock-like movement to a maximum of about two inches per second. When drawing jackets, it is usually better to push them through quickly to avoid rapid stick and release action that causes rings or uneven wall thickness along the length. But during setup of drawing and, for that matter, almost any other operation, using the speed control to slow the operation to a slow-motion demonstration can save time and parts. Slow motion of the ram lets you make sure of alignment.

Draw punches fit into the ram of the press, unlike external swage punches, which fit into the floating punch holder in the press head. The FPH-1-H punch holder fits into the 1.5-inch by 12 TPI head of the press for swaging operations, but for drawing, the punch holder is unscrewed and the draw die takes its place.

A draw die for the Hydro-press can be made differently from those used in hand press. Because of the long stroke and full power, the Hydro-press die can have a long guide section, a reducing orifice, and an after-guide section to maintain straitness. Most materials will tend to curve to one side or the other as they are drawn, following the slightest weakness in the material wall. With the carefully hand-lapped guide sections, jackets may be drawn very precisely without the bending, and with greater concentricity.

The design of bullet jackets is greatly simplified with a software program called DC-CUPS. This program has four main parts. First, it lets you calculate the material requirements and costs for making drawn jackets for virtually any shape and caliber of bullet. Second, it has the same capabilities for tubing jackets. You can determine the jacket length, cost, weight, how many feet or pounds of tubing you need for a given quantity of jackets, and work backward from almost any of these figures to get the others.

The program has the ability to store your jacket information and assign catalog numbers to them associated with the bullets you make (commercially), so you can keep a ready database of information as you learn what is needed for given bullets. And fourth, it has a math section that can calculate instant answers for complex volume, weight, and trig problems involved in jacket and bullet design.

Jacket-making die sets are always provided with matching punches. It is necessary to make the punch with the die for testing. The cost required to produce dies and punches is primarily in testing and adjusting dimensions to work with a given sample of tubing, not in the material from which the dies are made. Whether or not the punch was provided, the cost involved would be nearly identical.

I only mention this because on one or two occasions, someone has taken me to task for not offering part of a die set for a lower price. The rationale has usually been that since the person already had something that might work, they didn't want to buy another part like it. In some products that would be sensible. After all, if you only need a new fan belt, there is no point buying the whole engine to get it.

On the other hand, if you were having a new engine built, it wouldn't save you anything to tell the builders you already had the piston rings, so leave them out. In order to test and make sure the thing works, they have to install the rings and then afterward, spend more time removing them for you! It actually costs more, in some cases, to build something and not supply a part that is required for testing.

For example, if you want the empty frame for a four cavity core mould, it would seem logical that this ought to cost less than the complete mould. But we build the moulds in matching parts sets, just enough frame parts to go with the number of cylinders and pistons, because almost no one ever wants just the frame. Part of the operation is in machining the top of the mould with cylinders inserted so that the assembly is perfectly flat, preventing leakage of hot lead.

In order to supply an empty frame, we have to take apart a completed mould, which is twice as much work as just shipping the whole tool! Labor costs far more than material. If we had plenty of lead time, and could keep track of it well enough, we could schedule the production of one extra frame on the next production run. But keeping track of the special order, getting the information to the various die-makers and machinists at the right time, and making sure that the special job is set aside for a single order without anyone missing their cue and forgetting to step around the well-established procedures, can take considerable planning and logistical time, which someone must be paid to do.

As a result, a special order for a part that normally isn't made for replacement sales can cost more than just the production labor and parts would indicate. This is also the reason why replacement parts for some machine tools can seem vastly overpriced, and yet after studying the reason for the price, it makes good sense and is necessary in order to keep a handful of obsolete machine components available for years, taking up storage space as well as tracking and handling time.

I needed a replacement gear for a large but "obsolete" model of milling machine. It cost about half what the machine cost when it was new! My first inclination was to think I was being gouged. But after thinking about it, I realized that the machine tool people had paid to make and keep this part on hand for twenty years, keeping records of its location and paying for the storage space through many moves and changes, through conversion of their records to various computer systems. They were able to put it in my hands two decades later with just a phone call.

The cost of the gear was not what it cost to make. It was what it cost to make plus all the effort that had been expended making sure it would be there when I needed it. (Being a parsimonious soul, I had one of my die-makers build one instead, but after studying the time it took and the value of dies that were not made during that period, I decided it would have been wiser to just pay for the "overpriced" part and be done with it. Thinking like a person whose time is "hobby" valued is an expensive mistake for a person whose time is market valued.)

With custom shapes and materials for jackets or bullets, we are talking about developing handmade tools to do a specific job, not reaching in a bin and grabbing one of thousands of identical parts. Even a thousand dollar die set probably doesn't have ten dollars worth of steel in it. The value is in the effort and hard-earned knowledge applied to assure that the die set will work properly with a given job. A manuscript for a bestselling novel is worth more than the two dollars for the paper and ink that contain it. When you have a set of dies built for a specific job rather than choosing a set off the shelf, you are in effect commissioning the manuscript.

When you buy the press, on the other hand, you are buying a copy of the manuscript, because the development and design has been done previously. Instead of hiring a team of die-makers and machinists and designers to come up with a new press, you are paying a much lower amount for the parts, labor and skill required to assemble one that has been tested and proven many times over. Each standard product that we develop may have years of work in its design and testing, tens of thousands of dollars already invested in jigs, tooling, experiments that failed but pointed out ways to solve problems, and eventually resulted in the dimensions and tolerances, material specifications and techniques needed to duplicate the design and be certain it will work every time.

When you select a standard design for jacket drawing, using material that we provide initially, then you benefit from the work and money already spent on years of previous models and versions. When you select a new material or design, at least some of that work has to be done for you alone. The difference in cost is a direct reflection of that additional work. It is not arbitrary. We used to spend more solving unexpected problems with client-supplied materials or nonstandard designs than we quoted, and sometimes we still do. Naturally, if we're going to be around next time you need something special, it is in everyone's best interest that the price actually cover the cost of doing the work. Otherwise the die-makers will soon be back working for Lockheed or Hughes Aircraft, probably making more than they do in the firearms business (but perhaps getting less enjoyment from it).

A fellow wanted to buy a building site, and he asked the real estate agent how much it cost. The agent said it cost $50,000. When he asked why it was so high, the agent said it had a great view. If the fellow had asked how much it was without the view, you'd have a pretty good idea of the situation when someone asks me how much a die set is without one or more of parts I have to make in order to build and test that set.

I'm always tempted to finish that story by saying that the agent thought a minute, and said "Without the view, it's only $10,000." The prospective buyer said, "Fine, I'll take it," and wrote a check, whereupon the agent asked "Now, where do you want it delivered?"

But I won't.

Power Bullet Swaging

In writing this book, I am assuming that you are already familiar with bullet swaging, or that you have purchased one of the more basic swaging books such as Rediscover Swaging or The Corbin Handbook of Bullet Swaging. That is why you won't find a detailed description of bullet swaging technique, tooling, and examples of exotic bullet designs in this book. They are readily available in the others.

On the other hand, there are some operations that cannot be done at all on hand presses, and most of the information in the other swaging books assumes you will be using a hand press.

Also, there are both position and pressure controls on the Hydro-press. Some operations work best by stopping at a given pressure. Others work best when you stop at a certain position. I'll suggest the best combinations in this chapter.

The first operation in swaging a bullet is to produce the core. The lead filling or core of the bullet can be cut from lead wire or cast from scrap lead in a core mold. There is no particular problem with either one: some people like the convenience and speed and safety of using lead wire, others find the savings of using scrap lead worth the fumes and fuss of casting.

As for the end results, once you have passed the core through a core swage die, you can't tell any difference. With casing you can control the alloy. With lead wire, you have pure lead to work with. Using the Hydro-press, you can extrude lead wire with the optional LED-1 extruder kit. The lead can be purchased in round billets, from Corbin or other suppliers, or it can be cast with the tube molds provided in the kit.

You cannot extrude hard lead with this kit. But you can produce excellent, chrome-like lead wire from soft lead, and do it quickly enough to be profitable. You can even extrude hollow tubing with optional mould and extrusion punch components. However you do it, the cores need to be cut to length (if made from wire) and then swaged to precise weight and shape. Cast cores are typically cast to desired length, so you do not need to cut them. Some people have suggested that we make a very long mould so the cast cores can be cut to length, but with some consideration it becomes evident that casting them to length with an adjustable mould makes far more sense than both casting and cutting the same cores.

Making a swaged lead bullet without a jacket (but it can be with a gas check or Base Guard[tm] disk if desired) can be done in a die that for all practical purposes is identical to a core swage. This die is the Lead Semi-Wadcutter or LSWC die. We call it “semi-wadcutter” because any bullet it makes will have either a 90-degree shoulder of at least .015-inch width before any nose or base protrusion takes place. Don’t take this designation to mean some specific nose shape. It is a generic term that can be used with round nose, truncated conical nose, flat nose, bevel base, boattail base, hollow base, hollow point...you get it, right? The actual shape of nose or base after that little step can be whatever you want.

The reason this simple, one-step bullet making die must produce a small semi-wadcutter or SWC shoulder, regardless of the end shape, is that the die has a straight cylinder cavity fitted with two punches, and the shape of the bullet is a mirror image of the punch end. If you attempt to machine a cavity that comes to a feather edge, attempting for example to make a round nose bullet without any shoulder, the pressure applied to the inside of that cavity will be enough to shove the thin metal edge firmly against the die wall, and then rip off the paper-thin steel leaving a thickness of about 0.015 at the ragged edge of the punch.

So, rather than let the pressure create a rough edge, we machine the punch with a nice, even .015 thick edge. That is the right minimum thickness to withstand internal swaging pressures of 15,000 psi or so. If you try to use harder lead, and raise the pressure by doing so, or if you try to swage too rapidly, the pressure will exceed the tensile strength of the punch edge and give you a ragged .020 thick edge instead! To avoid that, we can design the punches used with harder materials and faster strokes with a thicker edge.

Both the core swage die (CSW-1-H) and the lead semi-wadcutter die (LSWC-1-H) are built in the same pattern. The die is a 1.5-inch diameter cylinder about 2.5 inches long with a hole precisely through the axis, and a reduced diameter shank with 1 inch by 12 turn per inch threads (1.0-12 tpi). The bore of this die is honed to a fine finish and exact diameter, and equipped with hand-fitted punches which are honed to exactly match with a sliding fit.

One punch fits inside the die, and has a portion that is the same length as the die, then a large “head” section. This punch fits into the threaded end of the die. The punch head rests on a shoulder within the press ram when the ram is raised. This holds the working end of the punch at an exact distance inside the die, above the threaded shank portion, in the large diameter section, when the ram is up. As the ram comes down, there is a hard steel bar through a slot in the ram, which eventually contacts the punch head and lifts it off the shoulder. As the ram continues down, the knockout bar comes to a stop against the large base plate of the press head. The ram and die continue down, but the internal punch is stopped by the knockout bar. At some point, the internal punch head will come up against the threaded end of the die, which means the working end of the punch is at the die mouth, and anything in the die is pushed out (ejected).

Usually, the end of the internal punch forms the base of the lead bullet. It does not have to, but keeping the internal punches primarily as base punches makes it easier to order different nose and base shapes since we can assume that the punch for a base is the long, internal punch unless otherwise specified. The nose is formed against the end of the external punch, which has a short head, a body section, and the working tip section that fits into the die mouth. The external punch is held in the press head by the floating punch holder. It is adjusted up and down to control how far the punch reaches into the die, and thus how much volume is left between the internal and the external punch tips when the ram is raised to the top position.

In either the CSW-1-H or LSWC-1-H die, the bullet weight is adjusted by extruding a small amount of lead from the core, through bleed holes in the circumference of the die. The standard design of die uses three identical bleed holes spaced at 120-degrees, just above the top of the internal punch tip when the ram is fully raised. (You can see that the distance from the top of the ram to the shoulder within the ram is critical, because it controls how far back the internal punch can drop, which determines the distance from the punch face to the mouth of the die. This distance is the maximum possible volume of material that will fit into the die, and is somewhat more than the maximum you can actually use to make a bullet since you must allow at least a full caliber of free movement for the external punch to align with the die.)

To adjust the weight of the bullet, first make your core slightly heavier than the bullet you desire. Anything from five to twenty-five grains more weight will do. The die cannot add any weight to the core, so if the tolerance or variation in core weight is greater than the difference between the nominal core weight and the desired bullet weight, you will have some lighter bullets. To determine the minimum surplus allowance, weight ten cores that you have cut or cast but not yet swaged. Add the total weight for all ten, and then divide by ten to get the average. Subtract the lightest core weight from this average weight. This is the minus variation. If you want to know the plus variation, subtract the average weight from the heaviest core weight.

Say your average weight is 160 grains and your minus variation is 5 grains. That means you can just get away with making a 155 grain bullet using those cores, but it would be safer to double the variation and make nothing heavier than a 150 grain bullet. That would leave 5 grains minimum bleed-off on all the bullets, insuring some resistance and pressure will be developed for all the bullets.

The rule of thumb is to find the minus variation, double it, and subtract from the average weight, and use this as the heaviest weight bullet for those cores. Of course, if you are starting to make the cores, you can just make them 5 or 6 percent heavier than the heaviest bullet you expect to swage, because the variation typically will not be more than 3 percent plus or minus. On a 50 grain bullet, 3 percent is 1.5 grains either way. On a 500 grain bullet, it is 15 grains either way. (Precision weight control is a percentage value of the total bullet weight, also, because it is the percentage and not some specific grains that makes the difference in bullet flight.)

Since forming a SWC type bullet and forming a core use the same procedure and settings, I'll just talk about swaging the core. You can apply it to making lead bullets in the LSWC-1-H die also.

Swaging the core cannot be done with the pressure reversing method. That is, you cannot set the pressure sensor to reverse the ram at a given level and come up with consistent cores. Why not?

First, consider the way a core swage works: the pressure builds up inside the die between two flat punch faces, until the lead fills the die space and begins to extrude through three bleed holes in the side of the die. Until this happens, the pressure is low and rises more or less in a linear way. When the cavity is filled with lead, the pressure rises suddenly, then changes rate as the lead begins to move through the bleed holes.

Increasing the pressure only increases the rate at which the lead spurts out. If you select any given pressure below the extrusion point, you will never change the weight of the core. Heavy cores will still be heavy, light ones still light. Once extrusion starts, it maintains a constant pressure for a given ram speed. That means, if you set the pressure to reverse at a given point above the minimum extrusion point, you'll only succeed in moving all the lead out of the die, or at least enough so that bleed holes are finally blocked by the incoming punch (which leaves the minimum possible core weight in the die).

Setting the pressure reversing mechanism to reverse the ram when the extrusion pressure is reached will only succeed in just starting an extrusion before it is stopped. That won't accomplish anything in regard to weight control.

The way to insure accurate weights is to set a fixed volume between the two punches. That is, you must swage cores by stopping at a given position each time. And that position must be such that the lightest core you put into the die still has greater length than the length between the final resting point of the two punches. Otherwise, some cores would not be adjusted at all and others would. Light cores would still carry their variations.

For core swaging, the pressure reversing mechanism is only used as a safety backup, or turned off. Set the pressure higher than the minimum required to move the lead. Then stop the ram at a given position, not a given pressure. If you wish, set the reversing pressure switch on and adjust the auto pressure control so it won't trip unless something goes wrong and the ram overshoots the top sensor (not likely).

I have noted before that you must have the pressure high enough so the lead comes out fast. If you set the system pressure so low that the ram can be stalled, or nearly stalled, you will get variations even if the position is controlling automatic reversal. Lead flows rather slowly, and continues to move while under any pressure. There will be differences in core weight determined by the length of time you hold the pressure and how fast you apply it. Use more than the minimum pressure required to flow the lead, and hold it for at least a few milliseconds by setting the top dwell timer.

If you have trouble with core weight variations, increase the pressure and the dwell time. If you still have trouble, check for loose components such as the nuts that hold the top plate on the guide rods, and coupling between the cylinder rod and the press ram, and watch for any side movement of the press head under swaging pressure. If you detect any noticeable movement of press head, use a torque wrench to apply even torque to both top nuts, and check the bottom nuts too.

But more likely than any of this is the misuse of the settings. Make sure that the position sensor is, in fact, controlling the stopping point. Switch off the pressure switch and try it. Move the top sensor down an inch and readjust the punch holder to match, to make sure you are not sitting at the end of the cylinder stroke.

If the cylinder top limit is reached, and the pressure reversing switch is on, then it is possible that reversal of the ram is being handled by the combination of the physical limit of travel (which normally just stalls the ram) and the rise in pressure at that point (which trips the pressure reverse mechanism).

The position of the ram can vary slightly because of inertia and temperature variations in the hydraulic system, slight differences in valve closure timing, and trip tolerances in the position sensor. Normally, the combined effect is not enough to be of concern. But bullet makers include perfectionists. Marketing of custom bullets involves the psychology of the buyer, who has only two precision instruments with which to test the bullets (other than—heaven forbid!—judging them on the size of the group they make in the target): the micrometer to check diameters, and the powder scale to check the weight.

There is an old saying to the effect that when your only tool is a hammer, every problem begins to look like a nail. This has never been more true of the target shooter who judges the potential accuracy of a bullet by the one thing he is sure he can measure accurately, the weight. Weight variation in the bullet is blown far out of proportion both figuratively and mathematically in regard to its effect on where the bullet will land. The average handloader probably does not grasp the difference between percentage of variation and numerical measurement of variation. The percentage of variation is what counts.

An easy way to illustrate this is to consider a .224 benchrest bullet and a cruise missile. The .224 bullet probably weighs from 50 to 60 grains. Let’s call it 50 grains. The cruise missile probably weighs about a thousand pounds, with warhead. That would be about 7 million grains, since there are 7,000 grains per pound. The decal that says “US Navy” might weigh about 25 grains. Assuming the missile lost direct guidance control and went into a stable ballistic glide toward the target, how much difference do you suppose it would make in where the missile landed if someone forgot to put the decal on it?

With a stable, balanced airframe the difference would be in the effect of gravity pulling on the difference between 7,000,000 grains, and 7,000,025 grains. The variation in weight is about 0.0004 percent. The difference gravity will make on the point of impact is so ridiculously small that no one would even give it a second thought. The variation in gravity itself from the influence of heavenly bodies or maybe even an aircraft flying overhead would be in the same ballpark.

Now what about the same 25 grain variation on the .224 bullet? Wow, that is half the weight or 50 percent variation. You better believe that will affect where the 50 grain bullet will drop (assuming the gun holds together when it fires a 75 grain bullet with the load expected of a 50 grainer).

Weight variation is important in its relation to total bullet weight. Stating a certain grain variation without mentioning the bullet weight is giving half a comparison. It is a standard advertising gimmick, but anyone who listens with more than half a brain unfurled scoffs at such statements as “this gun is 20% more accurate”. Most of us just smile and say to ourselves the other half of the comparison, “...than what? A slingshot?”. Yet when it comes to bullet weight variation, there is a universal tendency to cluck tongues and shake heads when we hear of bullets that vary by three grains or ten grains. Vary from what? A 900 grain 50 BMG slug? A 20 grain .17 caliber bullet?

In an attempt to quantify at least approximately how much variation, as a percentage, is acceptable in an accurate bullet, over the years I’ve done variations on this test so many times that I’ve long ago lost count: swage two piles of identical bullets, with the exception of core weight. Make one pile as precisely close to a given weight as I can, and make the other pile just as precisely a different weight. Shoot groups with both piles of bullets and note the group size. Then mix the rest of the piles together and shoot more groups, and see how much they open up.

To minimize the human factor, I frequently used a machine rest with a barreled action mounted on an inertial slide, and fired the rounds with a camera shutter release attached to the trigger. I also experimented with known amounts of imbalance, by putting a nylon string of known weight on the side of the core to unbalance it. Using different diameters of weed-cutting string and fishing line, I could apply more or less imbalance by percentage of weight. This let me compare concentric weight variation with eccentric variation.

To make a very long story shorter, group sizes were consistently larger when the concentric weight variation exceeded about two percent of total bullet weight. The average variation was very slightly larger but started to disappear into normal shot to shot variations with a one percent (plus or minus) variation, regardless of caliber or weight. When the variation was held to half a percentage, I could detect no difference whatever between shooting the mixed piles and all of one pile, using machine rests in windless conditions, better than benchrest conditions in most instances.

With eccentric (string down the side) variations of the same magnitude, the story was different. Groups would be as much as doubled by two percent variations, and noticeable out of the background fog statistics for normal groups even at half a percent. They were still as good as most factory bullets, but not as good as the best bullets I could make by hand testing each one.

The thing that stood out most to me was the size of the raw numbers compared to the percentages. When I was shooting my .222 Remington barreled action, with 52 grain bullets, a 1 percent variation was plus or minus about half a grain (0.52 grains) My powder scale instruction booklet said it was only accurate to 1 percent of full scale reading. That meant with 100 grains full scale, it was only capable of giving me plus or minus 1 grain. If this booklet from the manufacturer were to be believed, the scale really couldn't tell me that the 52.5 grain bullet was exactly that any closer than from 53.5 to 51.5 grains, or plus or minus 1 grain. Yet here I was, believing the scale to be the last word in precision and worrying about the variation in bullets.

Of course, the absolute accuracy of the scale wasn't as important as its repeatability. Maybe it was off by anything up to one grain either way, but it repeated the lie consistently and I couldn't find any justification to convict it of perjury. I was unable to locate any factory specification for repeatability on this or any of my other scales, just the accuracy figure. Most scales were only specified at from 1 to 3 percent of full scale reading, and most of them had a 250 grain full scale reading, so you can do the math!

Using analytical balance weights from a scientific equipment supplier, I checked the scales and found that they were well within the stated accuracy, although certainly not as precise as the expensive little weights. Converting the grams in to grains, I found that most of my scales read from half a grain to a grain and a half "off" one direction or the other from the plus or minus half percent weights in the 50 to 150 grain range. So much for the doctrine of scale infallibility, but hooray for the honesty of the specifications.

The moral is, figure percentage of variation as your standard for quality, not absolute weight variation. Holding better than 2% will make a good hunting bullet. Holding better than 1% will make a fine target bullet. If you manage to hit half a percent, plus or minus, you are in the zone of diminishing returns and need do no more even for benchrest shooting. In grains, this would mean a 50 grain bullet could be world class in every way and still have a variation of plus or minus 0.25 grains. A 168 grain bullet would need to maintain 0.84 grains plus or minus to meet the same standard. And a 450 grain bullet would be in the league of champions with a variation of plus or minus 2.25 grains.

Adding and subtracting these differences makes the point even more clearly: a good benchrest 50 grain bullet could weigh from 49.75 to 50.25 grains. The 168 grain nominal weight box of bullets could contain individual bullets that weigh from 167.16 grains to 168.84 grains, and the box of 450 grain bullets would be just as precise in weight control if the ranged from 447.75 to 452.25 grains. My guess is that the gut reaction most handloaders have, when they read that a benchrest bullet can have plus or minus half a percent weight variance, is to automatically translate that into plus or minus half a grain. Try to resist that temptation, because it makes you spin your wheels trying to hold far more tightly controlled weights than will have any practical effect.

Having said all this, let me go back to method of achieving tighter weight control. Since the electronic system is limited by the drift of the cylinder once oil is shut off, a way to overcome even this variation is to mechanically block the progress of the ram relative to the external punch, and then adjust the amount that the punch can reach into the die. The FPH-2-H positive stop punch holder can be used to do this job. It replaces the standard punch holder with a hardened, tempered unit capable of withstanding the full thrust of the press. Instead of holding the external punch in one position, it allows the punch to move up until the punch comes to rest against an adjustable stop.

This means you can run the die face against the end of the punch holder safely, and adjust the distance that the external punch reaches into the die cavity to set the weight of the core exactly. The ram cannot continue to drift upward once the die contacts the punch holder, so the distance between the internal and external punches is absolute and fixed, once you adjust it. But you need to change one thing. The mechanism for reversing the ram by position won't work now.

If you set the top sensor below the contact position of the punch holder and die face, you still have some drift between the sensor detecting the position of the ram, and the contact position. If you set the top sensor higher than the contact position, it will never turn on and the ram will just sit there, pushing forever until you manually press the "down" button.

Ah, but if you set it exactly at the right point, where the die and punch holder meet? Won't that work? Sorry, but it will only work intermittently because of the slight drift in position created by the hydraulics. Sometimes it will trip exactly right, but other times it will miss just enough to stop too soon or maybe not stop at all (in which case the punch holder and die face contact just holds the press in a stall).

The answer is to switch on the pressure reversing toggle switch, and set the pressure reversing level a little lower than the drive pressure, then move the top position sensor a little higher than the die face and punch holder contact position. Now, as soon as the die contacts the punch holder, system pressure will immediately head for the drive limit, but just before it gets there the pressure reversing transducer will switch on and initiate the dwell timer for the down stroke.

Yes, we are using pressure to reverse the ram during a core swaging operation, but actually, we are using a positive position stop to set the weight control and then bringing the pressure into it without any affect on upward ram movement. This is the ultimate weight control situation, capable of making bullets with weight tolerances below the rating of almost any handloader powder scale.

Core seating, on the other hand, can be accomplished more accurately by pressure reversal of the ram than by position. Suppose you do have slightly thicker or thinner jacket bases. If the jackets weigh the same, and the cores are accurately made, then quite likely your bullets will all be winners even with some slight variation in overall thickness or base variation.

If the walls are thick on one side and thin on the other, forget it. Those are not winners. (They might be fine for hunting bullets, depending on the range and the amount of wall thickness run-out.) Merely having some jackets with thinner or thicker walls by itself is nothing to worry about. If you seat the same core in a thicker jacket, it will typically stop closer to the jacket mouth, make a bigger lead tip on a lead tip bullet, and of course generate more pressure at the same position of punches during core seating. If the difference is more than a thousandth or so in thickness, the same diameter punch may leak lead around it with thinner jackets and tend to wrinkle or plow up jacket material in the thicker ones.

If you seat the same core in a thinner jacket it will generate less pressure at the same punch insertion depth. It will make a smaller lead tip or a little deeper core in an open tip. That is, it would if you used pressure rather than position as a criteria to stop pushing.

When you push to a certain distance between two punches and stop, you are assuming everything is perfect in regard to the jacket and core. If it is, you will get good bullets. If not, you will probably get bullets seated with a huge variation in pressure. This variation in pressure will do more damage to accuracy than the variation in jacket thickness ever thought about. Pressure translates to bullet diameter. It translates to the amount of base diameter or pressure ring when the point form and core seat die are not extremely close in diameter.

If you use pressure as a criteria to determine where to quit pressing, then each core will be seated to exactly the same pressure even if the jacket thickness does vary. The same pressure will translate to the same diameter, the same base expansion, and the same hole in the target. We are talking about small differences in jacket thickness here, not major ones. You always have some variation in everything. It is just a matter of proportion.

In core seating, set the system pressure to the point where you get a good consistent core and jacket diameter. Then set the auto pressure reversing to kick in just at that point. Finally, with the pressure transducer in control, raise the system pressure limit a little (100 psi) above that point so there is no chance of NOT reaching the trip point. And then, move the position sensor just above the place where it would normally take control from the pressure transducer, as a backup in case you put an empty jacket or light core into the die.

With point forming, some people get better results by reversing at a certain pressure. Others get good results with the position. Consistent pressure has more to do with the ultimate bullet diameter and taper, while consistent position has more to do with the degree of tip closure and overall bullet length.

The results depend to some degree on the consistency of the jacket. Harder or softer jacket material will translate into differences in both the length of the bullet and in the evenness and size of the tip. The smallest jacket tip diameter (meplat) is the diameter of the ejection pin hole, because the jacket material will simply follow the hole if you keep pushing the bullet further into the die.

Normally, the pressure that you use for forming a point with a conventional wall thickness and jacket material will be fairly low. Pressures of 200 to 300 psi on the Hydro-press gage are common (some thick, heavy jackets and extreme ogive shapes take more pressure). In most cases, the highest pressures are encountered in forming copper tubing jackets, in the end flattening or boattail forming stage. Core swaging pressure depends on the material resistance to flow, which with lead cores is related to hardness of the alloy.

Most soft lead cores use only a few hundred psi on the gage. Core seating depends on the jacket, base shape, and core hardness. Always start with a very low setting and work up until the jacket shows signs of expanding to the same diameter as a lead slug formed in the same die without a jacket. Stop increasing pressure as soon as you reach this point, because any more force only stresses the die.

With lead tip forming, you will probably have to use position because the pressure required is so low that there isn't much control left. That works out OK, since the tip shape is more a function of how far the punch is pushed down against the bullet than how much pressure is used.

Other swaging operations, such as forming a rebated boattail (which involves seating the core in two separate dies, first forming an angle and then shaping a rebate or step from the pressure of the lead forcing the jacket into conformity with the die), can be done either by position or pressure reversing. Generally it is easier to use position.

Of course, any operation can also be done by turning off both pressure and position switches, and simply letting the top sensor stop the ram. The UP and DOWN buttons manually control the ram movement. What is lost is the consistent timing that the automatic reversing logic provides.

In a few situations, it has been found that bumping the components two or three times produces a more perfectly formed projectile. This can be done by turning the dwell time to minimum and "jogging" the ram up and down at the top of the stroke. Using the AUTO mode works very well. If the ram is still going up when you press the DOWN button, it will reverse, then go up again by itself when you release the button.

My own favorite way of operating the press is to use a single stroke, AUTO mode. This involves turning the press to AUTO, and turning on the LOAD POS. switch. The component is placed in the die, which is initially raised to the loading position (just an inch or so above the bottom position).

The purpose of the loading position is to retract the internal punch enough to put another component in the die. Otherwise, if you stop at the bottom, the internal punch is raised to the mouth of the die (to eject). There is no convenient way to load in another part. You would have to sit the components carefully on the punch and hope they stayed while you pressed both buttons. Or you could raise the ram by pressing the UP button again and releasing it after the ram starts up.

With the loading position set up, you don't need to have your hands anywhere near the die when it is moving. The slight retraction of the internal punch gives you room to push the components part way into the die mouth, where they will be held. As long as you are reasonably careful about lining up the top punch (which, for the most part, is automatic since the punch hangs straight down and the mouth of the die is beveled to guide it and the components), the punch and die will go together nicely on each stroke.

The older models of the CHP-1 had mechanical switches with roller arms to sense the ram position. These units needed room to work, and limited how closely you could set the loading and bottom (as well as top) positions. The electronic proximity sensors, on the other hand, have a center to center distance of only 3/4-inch. Adding another half inch for the locking nuts still gives you about an inch and a quarter minimum spacing, which is fine. The long-discontinued CSP-2H Hydro Junior does not use a center or loading position sensor, so it can utilize two roller ram limit switches without crowding each other. This also simplifies the electronics, since each electronic proximity detector requires a slave relay to handle the switching logic, whereas the double throw roller limit switches can handle the current without relays.

Setting up the bottom sensor with any die (that has an internal punch) consists of installing the die in the ram, and running the ram down with minimum system pressure. When the ram stops, check three things:

1. Is the ram stalled against the punch head or did the bottom sensor light come on, indicating that the sensor stopped the press?
2. Is the punch pushed far enough toward the die mouth so you can get the component out of the die easily?
3. Is the big spring around the ram coil-bound or crushed, or is there still space between the coils as there should be?

In a few cases, such as with the forming of partitioned jackets and deep cup base bullets or heel-type bullets, you may want to adjust the bottom sensor so that the internal punch is just trapped by pressing against the ram and knockout bar as the bottom limit is reached. In this way, the punch will be held steady, locked against turning in the die. You can use a twisting motion, or even a soft-jaw pliers, to pull the part off the punch if it wants to stick.

When you receive a set of swaging dies, the instructions that come with them will indicate if there is any special mode of operation about which you need to be aware. The dies have been tested and have made bullets. Due to customs and border inspections, we may not always be able to include sample bullets with the dies (dies are just metal-forming tools, but people who don't understand shooting sports can go ballistic (no pun intended) about finding a sample bullet in the package. But rest assured, the dies were used to make some bullets before they were shipped. That is the only way we can find out if they work correctly or not.

A caution to observe is never to put anything into a swage die larger than its bore. It seems obvious, but let me repeat: swaging is the process of expanding a component to meet the die walls. Drawing is the process of reducing a component to a smaller size by forcing it through an open ring die. You never swage down, just like you never draw up. At least, if you value your dies, you don't.

From time to time, I'll get a point forming die with a piece of copper or brass rod jammed tightly into it, along with a broken ejection pin. The bottom of the rod will be 7/16" diameter or more, and the bore of the die will be .429 or less. Just an example: you can't expect a .437" rod to somehow gently release itself from a .429" diameter hole after you force it in under tons of pressure.

"I was just trying to swage it down," the note will say. Well, swaging doesn't go that direction. Drawing does. The dies are different. A drawing die is open on both ends and you can push the component all the way through it.

Just as often, I'll get back a punch that is either broken or severely scored and reduced in diameter with a note that says it didn't fit into the die. No, most likely it didn't, since it was made for the point forming die, which has a .308" diameter, and the unfortunate die that got the dubious honor of receiving the punch for a onetime visit happened to be a .3075" diameter rebated boattail pre-former. The easy prevention of this particular destruction is to try any punch into a die by hand. If it won't go, seems likely it might not be made for that die. Then, if all else fails, look at the markings on the die and on the punch. Punches have a code letter that indicates the type of die they fit, and a diameter or caliber indicated.

If you don't understand how to set up the dies, or if you have any trouble making the bullet, the first thing to do is contact us and describe the problem or ask how to get started. Or look on the web site www.Corbins.com for the information. Don't assume that the dies are "bad" if the bullet comes out undersized or you can't seem to get the results desired. Anything is possible, and if the dies are defective they will be replaced, but it is extremely rare. The most common problem is just that our instructions may not have been clear enough.

Maybe we didn't get it across that following the procedure really was important. Perhaps we didn't state clearly that the tubing jacket wall thickness or diameter tolerance needed to be within a certain range. Or, heaven forbid, maybe we sent you the wrong punch for the length of jacket or size of core that you intended to use, because we made an assumption that you were using something else.

All these things are easy to fix. Usually the hardest part is the communication, understanding exactly what is being done wrong, and why. Sometimes the most frustrating problems have turned out to be nothing more than misunderstanding about how something is done, or what steps absolutely must be done in the right sequence. Sometimes the issue is merely using a longer or shorter core, to make a different weight of bullet, with tooling that was tested and worked fine with some other length or weight range just outside of the one now desired.

Samples are always helpful. Send both samples of the components being formed, and samples of the bullet after it has been formed (or at least, the result of the step that isn't working as expected). If you do return a die, it is helpful if you also include the punches that are being used in the particular step in question, and some sample component parts just before they are used in this step. That way, we are using exactly the same material and punches as you. It avoids those instances where the problem is in the part that did not get sent back!

Power Swaging Business Tips

Over the years, we've made some very unusual punches to form fins, saw teeth, cross-splits, and a world of other odd designs for our clients. Each of these unusual designs has its own special considerations in regard to how the press is set up and how much pressure to use. A big part of the work that is done for you by the die-maker is the experimentation and determination of a working process while the dies are being made.

If you draw up a bullet design and take it to a regular tool and die shop, you may be able to get a set of tooling produced that will result in the bullet you want. But few die shops will deliver the process as well as the tools: in most cases, you will get a set of tools that matches whatever dimensions and tolerances YOU specified on the drawings YOU made. The die shop will present you with a bill, hand you the tools, and you are on your own thereafter.

The difference between that and coming to Corbin for tooling is that Corbin provides a completed process, not just the tooling. You can buy a method of producing something that may not have existed before, not just so many pieces of metal shaped to your specifications. In fact, we would much rather just have your specifications for the bullet and work out the tooling design and tolerances ourselves.

Because so much is possible with the Hydro-press, we often take on jobs that no one, including ourselves, has ever done before. And we can run into problems of design that no one considered, as a result. So, the more room we have to work with your design, the more likely it will work well and the less it will have to cost.

The processes described in this book work with most of the designs. But there are exceptions. The net result is that we need to have time to work out alternatives, work around potential problems, redesign where necessary, and perhaps even change the bullet design for easier production. Sometimes it takes nearly as long to develop and write up the instructions as it does to make the dies! If you should want a set of swage dies "immediately", and they differ from the ones on the shelf, you could be putting yourself in a tight spot.

It is best to avoid such situations: don't make commitments to your clients for delivery of bullets until you have the dies in hand. If the bullets are unusual, chances are no one else in the world can beat you on delivery (they'll have to take the NEXT set we make, at best). If they go elsewhere for dies, they will most likely pay far more and still have to wait quite a while. After three decades of developing the procedures for making swage dies, the Corbin die-works has streamlined the manufacturing to a point most shops could only approach by taking drastic shortcuts in quality.

Any die-works building custom tooling that has a reputation for good work will be backlogged, just as we are. If there is no one ahead of you in the queue and you just called, that might be something to think about. Why are other shops buried in work and this one is not? Word eventually gets around. The shops that are still in business after a few years are always the ones who offer good long-term value.

If your swage dies are unusual, and you plan to depend on them for making money, then by all means get a spare set as soon as you can afford it. There is nothing worse than waiting six months for the die-makers to struggle through their backlog and get your dies made, while your customers stomp out the door empty-handed. Accidents can happen. The cost of a spare set has to be balanced against the potential loss if you should break a die or damage a punch (or, as once happened, lose a die when one of the small children took it outside to play).

If you don't make at least twice what the dies cost every month, don't worry about it. But if you do, or if you could lose far more business during the downtime than a spare set costs, by all means don't count on the rapid replacement of a part to bail you out. We'll do our best, but there is also the mail or delivery service to contend with. They never lose anything, it seems, unless your whole business depends on it being there on time.

I have at least one client who NEVER orders unless he is completely desperate. Rather than getting a spare or planning ahead, he'll take the orders, get the money, and then call with a pleading voice to let me know just how critical it is that I drop everything and immediately save him, one more time, with a new caliber or a replacement part.

We have rush overtime service (first available weekend at twice the standard hourly rate, which just covers what it costs to bring in a special crew to make your die usually within 2 to 3 weeks but almost always within 30 days). I don't mind scheduling rush overtime work, but we only have so many overtime hours in a week, and when they are scheduled, we're just out of time for anything else.

I understand that once in a while we all need emergency service. What is hard to understand is why the same person would always need it on every order for years and years! A person who cares about his clients and wants them to be successful will try to accommodate emergency, rush orders. But it is difficult not to become just a little inured to the pleas after a while. After all, the rest of us have to plan ahead. I can't call up my steel suppliers a week after I run out of die stock and begin begging for emergency service every time. Management by emergency is an expensive mode of operation!.

You'll get the same thing, I'm sure, from your bullet clients. "I'm going to Africa at the end of the month, and I need five hundred of those special bullets right away so I can test my guns..."

How you respond will depend a little on what it might cost you. If you already have plenty of business to handle and putting this disorganized person first will push a lot of other orders back, maybe losing a few, then perhaps it's not worth the effort. Tell him to call you when he has a better idea of how long it takes to make custom bullets, and ask him how long he has known he was going to Africa.

On the other hand, if you are just starting and don't have many other orders waiting, maybe you could spend a few long nights and weekends getting his order ready. It could pay off. But be sure and let him know that you are doing him a favor this time, so he doesn't try to make it a habit of calling on such short notice.

Bullet swaging with the Hydro-press entails both mechanical skills and business skills. You'll get clients that are much more interesting than the usual walk-in trade of a "normal" businesses. Their needs are often quite challenging. It's a good idea to "check with the die-makers" before making too many commitments, both on feasibility and on delivery time. In most cases, you'll be the only supplier in the world for what they want, so it is worth while to do things right.

One thing that will eventually impress you is the swiftness with which all contact is lost in some cases when you ask for the payment before you begin. The words "I'll get back to you tomorrow..." are barely echoing in your ear before the click and dead silence sets in...forever. Do not feel bad: you have not lost anything. Those people never intended to pay you. They might have expected someone else to be talked into it, and most of these pie-in-the-sky, pay you tomorrow deals are based on several parties being involved, each of which is trying to get the others to do something of advantage to themselves.

I suppose there are some instances where a big talker can actually get an honest vendor to go ahead on the strength of bluster alone, buying all the materials and putting in all the work, and actually hand over the goods without seeing a dime. Maybe once. Maybe that is what these con artists are counting on. But any actual customer will understand that they need to pay for the bullets up front. You are not their bank and they are not necessarily your trusted buddy. If they need credit, and are worthy of it, they probably have a credit card.

Let me give you a little hard-earned business advice: if there is more than one person involved, forget it. Get them to nail it down to one buyer who is responsible for giving you the specifications, sending you the money, and receiving the goods. No matter how many wheeler-dealers are involved, let them jerk each other around and leave you out of the loop. You want a straight line from the buyer to you, and no one else involved. Any group, any size of organization, can—if pushed—appoint one committee head or supervisor to handle the entire deal with you and give you a valid credit card number. If not, you will most likely be left holding an empty bag at some point. The bigger the numbers, and the more people involved, the more likely it is that you'll be donating whatever you make.

The worst possible deal for a new bullet maker is for a supposed "engineer" to tell you what he wants made, another party to call in a few days to discuss the payment terms, a third party to send you written specifications, and the first guy to call back and give you a fourth party address where the items are to be sent. You get the idea. Either the folks with the money never authorized actual production or the person who placed the order didn't get the specifications right, and so forth.

Greed makes nice, reasonably intelligent people turn into business morons sometimes. The potential for a really big deal, something that could lead to millions of dollars in sales "later on", is a powerful sedative that puts logic to sleep. The custom bullet business is a pleasant, fairly high return operation but it has practical volume limits. The market for exotic, high performance bullets is a boutique market, not a mass market.

No matter what you may wish to believe, no matter how compelling a plan the feverish-eyed promoter breathlessly spells out while glancing nervously about for potential competitors, the fact is that most people build a reasonable income over time, a few small sales here and there, with a good sized deal coming along now and again, all with cash (check or credit card) up front. There are very few ideas that are so overwhelming that every shooter who is now perfectly happy with a mass produced standard factory bullet will throw away his supply and beg to buy this new concept instead.

It is just as silly to assume that there is no market for a custom bullet. Obviously there is, because over 450 people so far are making a living building and selling them. At least a couple hundred of them have taken the time to fill out a listing and send it to me so I can post it on our web site and publish it in our World Directory of Custom Bullet Makers.

There is always room for improvement, for new ideas, even in a field where hundred year old ideas still work pretty well. In fact, sometimes there is neglected income to be picked up by reviving some of the old ideas again, with modern materials and production methods. Check out some of the early bullet patents from the 1860-1880 era if you would like to review some interesting virtually forgotten concepts that may have appeal again today.

Production Volume

People who are looking at swaging equipment for the first time for a business often ask me about production volume: how many bullets an hour can be produced on which machines? The answer is that it depends on the bullet. Some designs can be swaged in one stroke, finished and ready to shoot. Others may take six steps or strokes of the press in different dies, and if you make the jacket, that can take from four to eight steps by itself.

Each step or press stroke usually takes about one second for two inches of travel. That is, if you are making a 1 inch long bullet, figure that it will take about twice the bullet length in press stroke to load and eject as well as form that part. So you would figure two inches of stroke, which takes about one second up, and another second down. Allow about a quarter to a half second of dwell time to let the lead flow properly. Then go through the motions of picking up a part, inserting it into the die, pressing the buttons, waiting two and a quarter seconds for the press to cycle, then reaching over and picking up the finished bullet to put it into a box. Time that and you have cycle time for one bullet.

I cannot just spout off the production rate and make any sense for the real world. I can make about 400 lead bullets per hour including cutting the lead cores from wire. Some jacketed bullets with flat bases take a total of nearly a minute for three stages, not counting manufacture of the jacket itself (since you may be buying jackets rather than making them). That would be about 60 bullets an hour. Some bullets can take enough steps so that you only get about 30-40 done per hour.

Production will depend on design and how many parts you are making versus buying. If you are making cores from scrap lead, it takes much longer than cutting them from wire. I can easily cut 1000 cores an hour, and only cast about half as many cores if you count the setup and cleanup times (which should be included and are seldom, by people talking about how many bullets per hour they can cast). I can work out the production time for a given product once we figure out how you are going to make it, but not usually before.

An interesting fact is that the people who make the most profit for their time are the ones who make the fewer bullets per hour! Making more production means you are making a more simple bullet, one that more closely mimics something that is either already on the market or can be swaged by someone with a hand press. That means you can't charge as much per bullet, because there is more competition. People have other alternatives, and some of them are fairly low cost.

If you make the kind of bullets that take a couple of minutes per bullet (and of course, we mean you would make 100 or more cores, change dies, seat all the cores in jackets, change dies, form all the points...not make each bullet from start to finish by itself), then the design is more exotic, and fewer people will be able to offer something like it. If they can compete, it will have to be at a higher price because they, too, are going to spend more time building it. I would rather sell 20 bullets an hour for $2.50 each than to sell 500 bullets an hour for a dime each. Wouldn't you?

As a very rough guide, figure about 400 bullets per hour per press for lead paper-patch or pistol bullets, 200 bullets per hour for jacketed semi-wadcutters, and 100 bullets per hour for most flat base rifle bullets. You may do better, but that is a good starting point. If you also make the jackets, figure about 50 bullets an hour.

There are two different kinds of bullet markets. One is relaxed, pleasant to serve, low pressure and geared toward high quality at low volume, with relatively high prices per bullet. The other is geared toward high volume, low prices, and consequently toward high competition, lots of pressure, frantic negotiations and sharp dealing.

If you like pressure and enjoy risking large amounts of business on the prices you bid, then you should investigate the cast bullet market. Mass production by using casting is very common in the U.S.A. today. Cranking out tens of thousands of bullets a month for a few cents profit per bullet, and going head to head with every other cast bullet maker based primarily on who can underbid everyone else for a police department or a big reloading outfit's business, is a way of life for many businessmen.

It can be profitable. It most certainly will be stressful. The problem is, anyone can buy a casting machine, set it up in a garage or outbuilding, and start competing with you. What can you do to make your bullet more desirable? Can you make it harder, more accurate, use better lubricant, offer a different shape? Yes, that's about it. There is nothing that fundamentally different from one cast bullet to another.

In the final bids, it all boils down to price. Cast bullet buyers, for the most part, are interested in how many bullets they get for a certain budget amount. Nothing else matters quite as much as the cost. Just about any hunk of lead will shoot good enough for most of them, because, in reality, a cast bullet typically is in .38 caliber, has a wadcutter nose and a hollow base, and has the same Alox-Beeswax or dipped dry lube as everyone else (with minor variations). Or you could say the same thing about a 9mm, or a 40 caliber, as the years roll on and the popular calibers slowly change.

When you compete on price alone, you are in a commodity market. Two people cause you grief. The cut-rate operator who isn't really making any money and won't be around next year, can take away this year's contract. He doesn't know he is working for nothing. Most of them have no idea how to figure their profits, and quite a few don't pay their taxes, pocket anything they make, and have a limited amount of lead that they got "for nothing". When it is gone, when the IRS finally realizes they are a business, and reality catches up to them, they'll be out of business.

Meanwhile, you lost a big one. If you can hang on until next year, or the year after, perhaps you'll get it back. Or, another would-be bullet caster will pop up to try the same thing.

The other person who can force you into a no-win situation is the large, efficient manufacturer. This is just plain old capitalism working to the benefit of the ultimate buyer. The guy with lots of money to put into his operation can buy faster, more effective tools, hire more people, get lead in bigger shipments at lower cost, and do the marketing on a higher level. He can afford to send representatives to the State police buyer, and visit with the major ammo loading firms every month. Even without taking the purchasing agent on a fishing trip, there is a great deal of perfectly legal "politicking" activity a large firm can afford and a small one can't.

His price is as good or better, and he has the presence that a small outfit can't afford. So, who gets most of the business? You have to depress your profits to make up for his lower costs, if you want to compete. Or, you have to try to beat him on delivery or haul the bullets yourself to save freight costs. It can be done, since it is being done every day.

But I would like to expose a different kind of market and help you understand it. The custom bullet maker, by definition, is not a mass producer like the cast bullet outfit. Custom swaged bullets are made in small quantities for individual users. People come to you, not the other way around.

The kind of people you deal with are primarily buyers who are not so concerned with the cost as with the design itself. They want something that cannot be purchased from a mass producer. Hornady, Speer, Sierra, Nosler, Remington—none of them offer what these people want. Perhaps they could, if the numbers were vastly larger. But, given the limited market size, the economics simply preclude any competition from the bigger outfits.

Who are we talking about? Handloaders, businesses involved in ballistic work, government agencies and contractors for the agencies, firearms firms who do not manufacture bullets but would like to experiment, owners of expensive but rare calibers of guns for which there are no bullets, wildcatters who have a hot idea for a bore size or bullet weight that can't be found, owners of obsolete and discontinued calibers who would like to shoot them, big game hunters who spend thousands on trips to other continents and want the absolute best in their bullets: get the picture?

In other words, the market consists of people who want a limited quantity of a special bullet. There is nearly always a market for between 5,000 and 50,000 of just about ANY unusual bullet caliber, shape, weight, or design per year. This is a pretty good rule of thumb. With more than 450 people making a living at it today, I think I can offer some solid proof.

Pick something. Anything. Say, a .412-inch bullet. OK, who would buy it?

Looking through the Corbin Technical Bulletins, Volume III, you'll find the .405 Winchester shoots a .412 bullet. Make it with a one-caliber elliptical nose and reduce the front half, above a single cannelure, to about .404-inch diameter. You'll have a bullet that works in the magazine and chamber of the 1895 Winchester, and you'll have a market both among the owners of original rifles and replicas or modern reproductions from Browning.

Make up samples, write a cover letter, take some black and white photos and have them reproduced. Send this publicity kit to fifty of the top writers who have expressed an interest in the .405 caliber or written anything about lever actions or the .405 caliber. Read the gun magazine columns and send samples to anyone who has an antique or reloading column. Write to Browning, and any other manufacturer of guns that shoot this caliber. Tell them you'd be interested in being mentioned as a supplier, and you're available if they have any special projects for custom ammo. Keep this sort of promotion up for at least three months, one mailing per month, and you'll see your products mentioned in a national magazine.

One major article, and you can just about count on being the world's leading supplier of specialty .405 bullets. A couple of mentions in the middle of a column, and you can afford to expand to other calibers and repeat the process. Even a passing mention buried in an article about something else will bring inquiries and business from the far corners of the earth.

Obviously there are other ways to get the business, such as trade shows, personal visits to distributors, contacting arms companies about special bullets for their guns, talks or seminars at which you can present your case, and a myriad of other markets besides the obsolete caliber market. Specialty big game and defense handgun bullets are two rich markets for the custom bullet maker.

But the point is that you can make as good a living by offering a limited number of bullets at a high price as you can by offering millions of bullets at a very low price.

I believe you would find it enjoyable, affordable, and that your chances of success would be excellent because of the experience that is available to you through Corbin's books. The typical custom bullet sells for no less than 40 cents each, an average price of one dollar, and top offerings go for as much as $3 per bullet. Naturally, you are selling small packages to individuals at these prices, and probably selling direct by mail. As a result, the profits are not shared through several layers of distribution, and you make a much higher percentage than you would by handling large volumes through typical distribution channels.

Your market is much smaller, of course, but it is also less competitive. If the demand for a given bullet design of this type reaches only about 50,000 bullets per year (a typical figure for custom bullets), then this would mean selling only 1,000 customers a box of 50 bullets, or perhaps selling 50 customers a shipment of 1,000 bullets. The world is your market: you will not usually find enough local buyers to make it worth while to advertise in the newspapers.

Magazine and trade show promotions are the typical media for reaching the clients you need. In every major city of 250,000 or more people, there might be one person who has a need for the bullet you offer. How many such cities are there? I count at least 56 in the U.S.A. alone. With nearly 240,000,000 people in the U.S.A., if you only had a one in one million chance of selling anyone a box of bullets, you could still sell 240 boxes!

How much do you make on a box? On the average, you can produce about 50 exotic, tubing-jacketed bullets per hour. (Or, you can make about 400 lead bullets an hour—production depends on design). At a mere 50 per hour production rate, you could make 240 boxes of 50 bullets in 30 days, working 8 hours a day. Or, in 40 weekends, putting in 6 hours a weekend.

If you put a labor cost of $10 an hour on your time, you would have $2,400 in labor cost in those bullets. The material cost is typically about twenty cents, so you would have another $2,400 in those 12,000 bullets. Your cost, including your own pay for labor, is $4,800. At the typical selling price of one dollar per bullet, your gross on the 240 boxes is $12,000.

That means your profit, over and above the $10 per hour you made on your labor, is $7,200. And the time it took to generate this profit was only 240 hours, or 30 days. Would you trade $10 an hour pay plus a $7,200 bonus for one month of work? Do you think you can make this much money, this quickly, selling cast bullets? This is based on a one-in-a-million chance of making a sale! The odds are probably a lot better than that, don't you think?

On the other hand, it will take a while to sell that many bullets in this kind of market. Reaching those people is the slow part. You must learn to get free publicity by a constant flow of press releases, pictures, stories, samples, invitations to interview, and even personal visits to writers and magazines. Without some attempt here, nothing else will happen. Those few people who have tried the low volume, high profit approach to bullet making and gave up, usually failed to appreciate the value of widespread publicity.

It bears repeating: you cannot count on selling your bullets locally. What your friends and neighbors shoot normally has nothing to do with your success in custom bullet making. Most people in any given area shoot standard, off-the-shelf bullets. You can’t market to “most people”—the major bullet firms have got that covered. You must market to the top few people, the experimenters, the serious hunters, the businesses, the contractors. And unless you are uncommonly lucky, there are not enough of them in any one area to let you get by with just local promotion.

Of course, take your projectiles to the range and try to sell locally, but don't count on enough volume to make a living. The volume in custom bullets comes from widespread publicity.

Let's make a comparison. Suppose you purchased a high volume punch press capable of turning out 40 bullets a minute. This will cost you about $85,000 with all the tooling, feeds, development time, and a reasonably-priced used machine. And suppose you also purchased a Hydro-press with tooling for about $8,000 to make an exotic bullet at a rate of about 50 per hour.

The market for exotic bullet will stabilize at no more than 50,000 per year in almost all cases. So, right off the bat, you would have wasted money buying the faster machine. After you have run the high-speed machine for less than 3 days, you will have all the bullets you can possibly sell for the next year. But the money you paid is tied up just the same.

If you decided to lower the price and thus attempt to increase the market size, you might be able to sell more bullets and justify the fast machine. Let's see what happens to the figures....

With a market for 50,000 bullets a year at a dollar each, you could gross $50,000. Your cost per bullet on the Hydro-press, including a $10 per hour labor cost, would be 40 cents each. Your profit is 60 cents each. Your investment cost is $8000 for equipment, and your return on investment on 50,000 bullets per year is $30,000 profit divided by $8000 equipment cost, or a whopping 375 percent!

With the high speed press, you might be able to take that $10 per hour labor cost and come up with 2,400 bullets during the same hour. This drops your labor cost per bullet to only 0.004 dollars, less than half a cent. Now, only the material cost remains the same at 20 cents. Your cost per bullet is a total of 0.204 dollars. By cutting the selling price to compete with the other mass produced bullets you might get closer to their kind of volume. Suppose you reduced the price to thirty cents each.

Now, with a selling price of 0.300 dollars and a cost of 0.204 dollars, you are netting 0.096 dollars per bullet, almost a dime each. In order to make the same money as you made by just producing 50 per hour on the Hydro-press, you would have to sell 312,500 bullets a year. And maybe, at that price, you could.

But why bother? Look at what you would have done: the return on your expensive high speed machinery investment would only be $30,000 divided by $85,000 or 35.29 percent! That's a good return, of course, but not nearly as good as you would have with the much less expensive, smaller, easier to buy Hydro-press system. You are settling for nearly ten times smaller return on your money!

And look what you have to work with: a mass market where price is starting to have the upper hand over quality, a great deal more distribution cost (which we didn't even consider) moving over a quarter million bullets instead of just fifty thousand, and of course the much higher costs of packaging all those bullets.

You had to spend ten times more money for the equipment, and typically the machinery is much less versatile than a slower machine. Speed brings dedicated automatic feeds and highly specialized transfer equipment. The machine that is optimized to handle 40 bullets a minute is designed to handle exactly one weight, style, caliber, and shape of bullet at that speed. Change anything, and you have to change a lot of things.

The Hydro-press, on the other hand, is designed to be easily set up and running a new product of a totally different style, caliber, and shape in seconds. Since you drop the parts in by hand, there is nothing to change except the die and punch. Even the setup of the machine is very close to identical for various sets of dies. The position of the punch holder is the main variable.

There are 8 hours available in a standard working day. There are 365 such days each year, giving you 2,920 hours a year to make bullets if you desire. If you make only 50 bullets an hour, you could possibly make 146,000 bullets year by yourself. For the price of another machine and another $10 an hour , you could hire someone to make another 146,000 bullets a year. If you can make $30,000 on sales of 50,000 bullets, you can make $87,600 for every machine and person you put to work, per year.

Labor intensive? Slow? Sure. Profitable? Safe? You bet!

Why would anyone fail to consider this remarkable opportunity to have fun in a low-pressure, relatively low investment business in favor of high cost, high pressure, high competition alternatives? Beats me. Must be tradition, or lack of vision, or fear of the unknown

-- maybe just stupidity. Whatever reason, it means that less than 250 people now offer their wares in this field and the market goes begging for hundreds of other special offerings.

As a retirement business, or as a profitable way to enjoy more shooting, you could put in one solid weekend a month instead of worrying about running a full time business. With only 16 hours a month (a couple of Saturdays), you could make 800 bullets a month and sell them at a profit of $480. Would an extra $480 a month cover your shooting expenses?

How long would it take to pay for a complete Hydro-press system, dies, and accessories at that rate? If you paid $8000 for the whole package (which is figuring a little more than average in 1992), you'd have it all paid for in 16.7 months, or about a year and a third. That's working only two days a month at it!

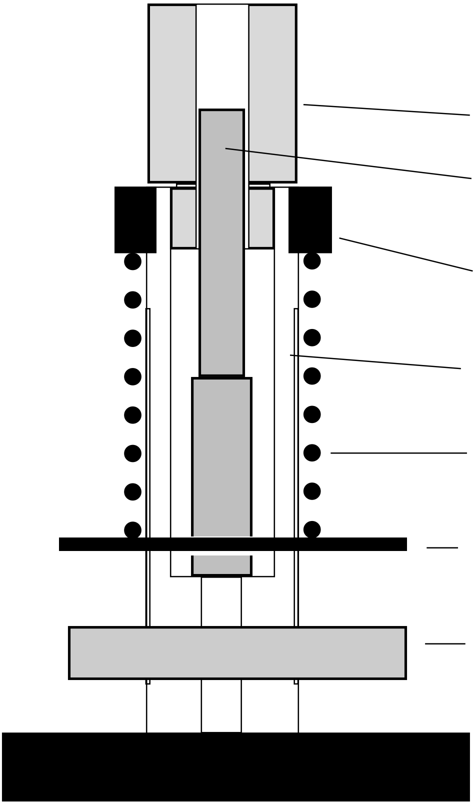
Now, suppose you took out a 24 month loan on your car, and bought the system with that money. If the bank charged you 15 percent interest, you would still come out with a profit at the end of the two years, and you'd own a system that could make a living any time you wanted to put out the effort.

High volume doesn't necessarily mean high return on investment. Normally, it is just the opposite in this field, because the market for any specialty bullet is limited. When you think about the firearms marketplace, you have to scale your marketing to the relative size of the field. It is easy to overestimate its size. It is so much safer to approach the field as if it were a "boutique" market, one with a limited, special appeal to a small percentage of the population who, nonetheless, will spend a higher than usual proportion of their income on it.

Getting statistics on the number of handloaders available to buy custom bullets is difficult. Some estimates place the handloading population in the U.S.A. alone at about four million people. Most handloaders shoot more than one caliber, so your market for calibers is perhaps double the number of people. Saturating the market would be easy with high volume, low cost production in any one caliber, but spoiling it by having too many entries of low volume, high quality offerings seems remote.

There are hundreds of calibers to be offered. As of this date, perhaps eighty are being produced, many of them by only one person each. Geographic considerations may have some effect on

How to Use the Retraction Pin and KO Bar



Several heights of KO Bars are provided with the Mega-Mite press to use with different lengths of dies and punches. Because the stroke length of the Hydro-press and Hydro Junior is adjustable, only one height of KO Bar is required for all lengths of dies and internal punches.

The KO Bar (or ejector bar) is placed through a slot in the press ram, so that half of it projects on both sides of the ram. When the ram goes down, the KO Bar eventually comes to rest on the base plate. The ram continues to move down, carrying the die with it, while the internal punch rests on top of the KO Bar, and ejects the component.

The Retraction Pin (a 1 / 4-inch diameter steel pin with a pointed end) also fits through the ram slot, for internal punches having a hole in the punch head. It goes under the Retraction Spring, and pushes down on the internal punch to positively retract it when the ram goes up. Raise the ram to insert the KO Bar and the Retraction Pin.

To determine the correct height of K.O. Bar in the Mega-Mite hand press, start with the shortest bar and see if the internal punch comes to the top or mouth of the die when the ram is lowered all the way. If the internal punch is not pushed to the end of the die, components will not be fully ejected. Change the K.O. Bar until the punch reaches the top of the die when the ram is all the way down.

If the bar is too tall for the length of punch and die, you won't be able to lower the ram completely, because the K.O. Bar and punch combined length will stop the ram movement prematurely. Insert the height of K.O. Bar which allows the ram to go completely to the bottom of the stroke.

Not every internal punch has a hole for the retraction pin. Those punches which require positive retraction have a hole and use the pin, and those which will be pushed down naturally by the full diameter component do not use the pin. To insert the retraction pin, put the internal punch into the die and screw the die into the ram. Then raise the ram so that there is room to put the pin under the spring.

Do not insert the pin between coils, because this can damage the spring and may fail to properly position the punch. The pin always goes beneath the spring. If the hole in the punch not positioned so that you can put the pin through it, you can unscrew the die slightly to turn the punch, and use the pointed end of the pin to gently pry the punch down below the bottom coil of the spring (by inserting the tip of the pin temporarily into the hole, between coils, and working the punch down).

Note that because the bottom position can be adjusted on the CHP-1 Hydro-Press, there is only one size of knock-out bar required, even though the ram design is similar to the hand press (not identical, however: the rams do not interchange, although the dies and punches which fit the rams work in both presses).

Maximum Safe Die Pressures

CHP-1 Hydro-press™ (3.25" cylinder)

Caliber (inches)	Gauge Pressure	Die Wall Thickness	Ram Force (Pounds)	Internal Pressure
.172	520.7	.364	4,319.6	185,905
.224	839.2	.338	6,962.1	176,667
.243	996.2	.329	8,014.9	172,821
.257	1,062.0	.322	8,810.5	169,842
.264	1,111.0	.318	9,213.1	168,309
.277	1,201.0	.312	9,966.7	165,388
.284	1,251.0	.308	10,375.0	163,777
.308	1,420.0	.296	11,777.0	158,065
.312	1,448.0	.294	12,101.0	157,086
.338	1,628.0	.281	13,509.0	150,557
.358	1,764.0	.271	14,631.0	145,355
.375	1,875.0	.263	15,554.0	140,828
.406	2,066.0	.247	17,136.0	132,364
.412	2,100.0	.244	17,424.0	130,699
.416	2,123.0	.242	17,613.0	129,584
.429	2,194.0	.236	18,204.0	125,942
.452	2,310.0	.224	19,164.0	119,431
.458	2,338.0	.221	19,394.0	117,721
.512	2,536.0	.194	21,041.0	102,198

Notes: Maximum gage pressure for the CHP-1 is 2000 psi. To calculate the corresponding gage pressure on a CHP-1 equipped with 4-inch drive cylinder, take 66% of the gage pressure above (multiply by 0.660). When swaging hard materials such as copper, use the starting diameter of the rod where it contacts the ogive of the point form die, instead of the die caliber, to determine maximum pressure.

The press should never be set past 2,000 psi on the gage. For core swages, use the actual diameter instead of caliber. Pressures are for slowly applied force: impact or rapid approach of the ram will produce higher initial pressure than the static gauge pressures indicate. Ram travel may need to be reduced to less than two seconds per inch with materials having a hardness over Bhn 5.

Die Pressure per 100 PSI Gage

Caliber	Pressure	Caliber	Pressure
.172	35,703	.355	8,381
.224	21,051	.357	8,288
.243	17,888	.358	8,241
.257	15,992	.366	7,885
.264	15,155	.375	7,511
.277	13,766	.410	6,283
.284	13,096	.412	6,223
.308	11,134	.416	6,104
.312	10,851	.423	5,903
.318	10,445	.429	5,739
.323	10,124	.452	5,170
.333	9,525	.458	5,035
.338	9,246	.475	4,681
.348	8,722	.512	4,029

Note: These figures are accurate for the CHP-1 Hydro-press™ with 3.25" drive cylinder.

Formula for gage pressure:

$$Pg = 1.23PD^2$$

Pg = gage pressure in PSI
D = caliber (diameter)
P = internal die pressure

(This only applies to the CHP-1 Mark IV press with a 3.25" diameter drive cylinder)

Press Tonnage for Gage Pressure

(CHP-1 Hydro-press[tm], 3.25" cylinder)

Gage Pressure	Ram Force (lbs)	Ram Force (tons)
100.0	829.58	.41
200.0	1,659.15	.83
300.0	2,488.70	1.24
400.0	3,318.31	1.66
500.0	4,147.88	2.07
600.0	4,977.46	2.49
700.0	5,807.04	2.90
800.0	6,636.61	3.32
900.0	7,466.19	3.73
1,000.0	8,295.77	4.15
1,100.0	9,125.34	4.56
1,200.0	9,954.92	4.98
1,300.0	10,784.50	5.39
1,400.0	11,614.08	5.81
1,500.0	12,443.65	6.22
1,600.0	13,273.23	6.64
1,700.0	14,932.38	7.47
1,900.0	15,761.96	7.88
2,000.0	16,591.54	8.30

Formula for ram tonnage:

$$T = 0.004148\ Pg$$

Pg = gage pressure (psi)
T = tonnage
(multiply by 2000 to obtain force in lbs)

Formulae Used in Swaging Calculations

Thickness of die wall:

$$t = 0.5(D - C)$$

D = die OD
C = caliber.

Die pressure:

$$Pd = (PsDc^2)/C^2$$

Ps = system oil pressure
Dc = Drive cylinder diameter
C = caliber

Lame's equation for cylinder wall thickness:

$$t = (C/2)*(SQR((s+Pd)/(s-Pd))-1)$$

C = caliber
s = tensile strength of die material
Pd = internal die pressure
SQR = square root operator

Maximum die pressure:

$$Pmax = (2st^2+2tCs)/(2t^2+2tC+C^2)$$

t = die wall thickness
C = caliber
s = tensile strength of die material

Maximum pressure in Hydro-press^{tm} dies (1.5" OD):

$$Pmax = (200,000 * (.81 - C^2))/(.81 + C^2)$$

C = caliber

Volume in a billet (cylinder):

$$V = 0.7854 * L * D^2$$

L = length of billet
D = diameter of billet

Volume from weight and density:

$$V = W/d,$$

W = weight
d = density

Weight from volume and density:

$$W = V * d$$

V = volume
d = density

Length of wire (inches) produced from billet:

$$L = 1.273 * W/(d * C^2)$$

W = weight of billet
d = density of the lead, (.4097 lb./cu-in)
C = diameter of lead wire, inches

Weight (lbs) of wire or billet for given length of wire:

$$W = .7854 * d * C^2 * L$$

d = density of the lead (.4097 lb./cu-in)
C = diameter of lead wire
L = length of wire

Area of a punch or cylinder:

$$A = .7854 * C^2 \text{ or } A = Pi * (C/2)^2$$

C = diameter
C = $w/(id^2)$

Density of material:

$d = W/V$

W = weight
V = volume

Surface area of a cylinder:

$A = 3.1416 * C * L + 1.571 * C^2$

C = diameter or caliber
L = length

Weights:

437.5 grains = 1 ounce	16 ounces = 1 pound
7000 grains = 1 pound	2000 lbs = 1 ton
2204.6 lbs = 1 metric ton	15.43 grains = 1 gram
453.6 grams = 1 pound	28.35 grams = 1 ounce

Volume:

16.383 cc	= 1 cubic inch
1728 cu-in.	= 1 cubic foot
27 cu-ft.	= 1 cubic yard

Water Conversions:

1 gallon	= 8.33 lbs
	= 0.13368 cu-ft.
	= 231 cu-in.
	= 3.78 liters
	= 0.83 Imperial gallon

Power conversions:

1 Horsepower	= 746 Watts
	= 550 foot-lbs/sec.
	= .707 BTU/sec.

Ballistic Relationships:

$$E = wv^2 / 2g$$

$$S.D. = w / d^2$$

$$C = S.D. / i$$

C = ballistic coefficient
w = bullet weight in pounds (lbs.)
v = velocity in feet per second (fps)
d = diameter of bullet in inches (in.)
g = acceleration of gravity (32.16 ft/sec^2)
i = coefficient of form (Ingall's chart no.)
S.D. = Sectional Density
E = kinetic energy in foot-pounds (ft-lb)

Volume of a Half-ball (round nose):

$$V = Pi\ d^3 / 12$$

Pi = 3.14159...
d = diameter (caliber)

Volume of a Cone:

$$V = Pi\ r^2\ h / 3$$

r = radius of base (caliber/2)
h = height of cone (length from base to tip)

Volume of a Truncated Cone:

$$V = Pi\ h\ (r_1^2 + r_1 r_2 + r_2^2) / 3$$

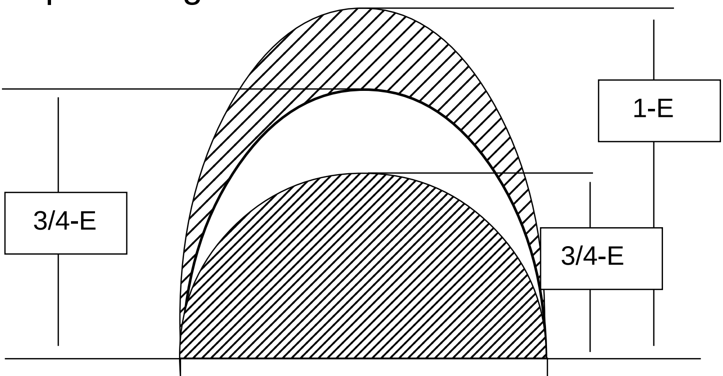
h = height of conical section
r_1 = radius of base
r_2 = radius at tip

Volume of an Elliptical Ogive:

$$V = Pi\ a\ b^2 / 3$$

a = length of ogive
b = caliber

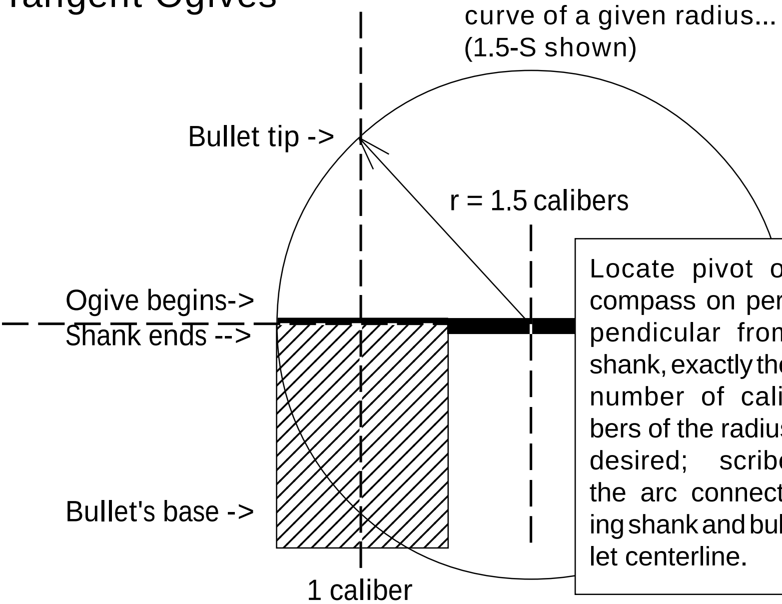
Elliptical Ogives



Common elliptical ogive shapes (.5-E is the same as .5-S, a half-ball). Elliptical ogives are measured along the bullet centerline axis from start of ogive to the tip. The ogive is half an ellipse.

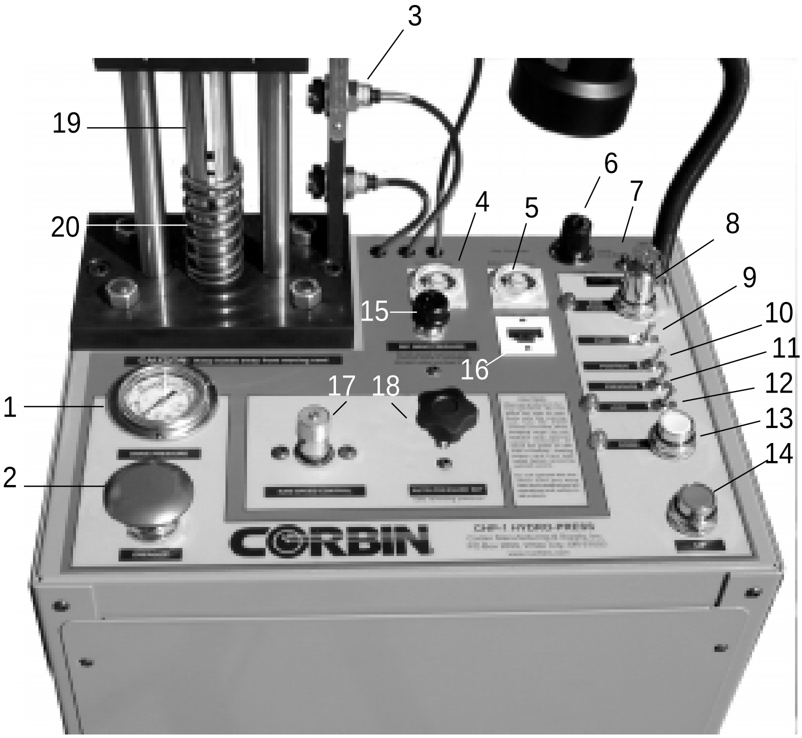
Tangent Ogives

How to draw a spitzer ogive curve of a given radius... (1.5-S shown)



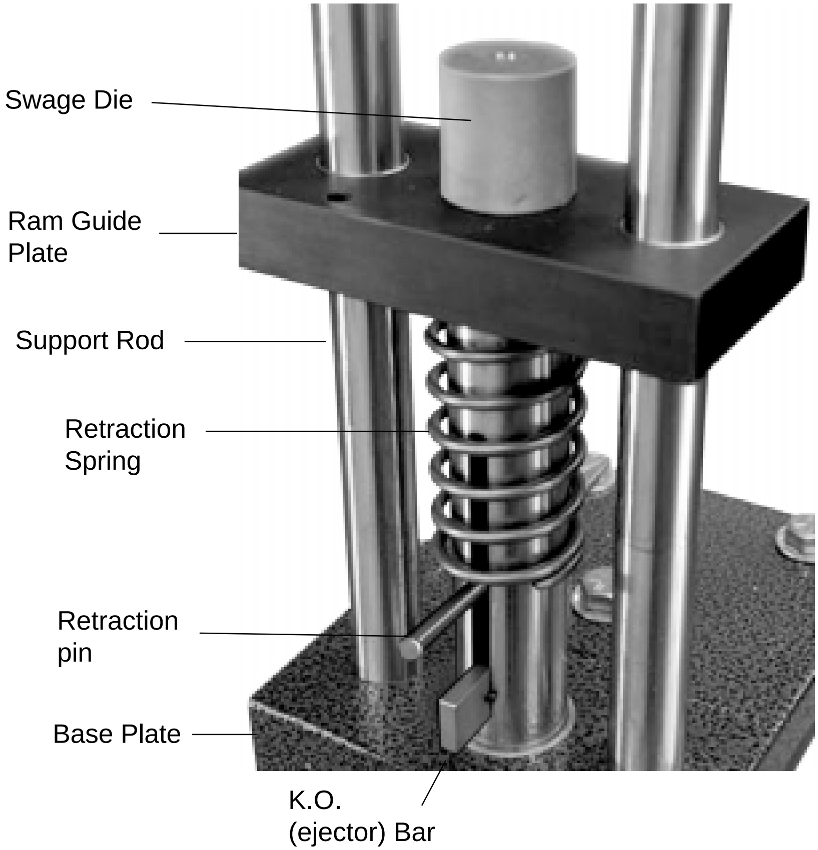
Locate pivot of compass on perpendicular from shank, exactly the number of calibers of the radius desired; scribe the arc connecting shank and bullet centerline.

CHP-1 Control Panel



1. Pressure gage (drive pressure)
2. Energize button (green, left hand master control switch)
3. Position sensors (middle sensor indicated)
4. Dwell time control (top of stroke)
5. Dwell time control (bottom of stroke)
6. Accessory jumper plug/socket (automatic stripper)
7. 5-Amp control circuit breaker (behind key switch)
8. Power key switch (off, manual, auto-stroke) and red Auto light
9. Pump motor (20-amp breaker switch)
10. Top position sensor reverse on/off switch
11. Pressure reversing transducer on/off switch
12. Load position stop on/off switch and green load light
13. Down button (yellow) and yellow down cycle light
14. Up botton (red)
15. Drive pressure setting control
16. Stroke counter (with reset button)
17. Ram speed control (for UP stroke)
18. Automatic pressure reverse transducer setting control
19. Ram
20. Retraction spring (around the ram)

Retraction Pin and Ejector Bar Assembly



The Retraction Pin fits through a hole in the internal punch head for those punches which require it, beneath the last coil of the Retraction Spring. The ram must be raised to insert the pin.

The K.O. (knock-out) or Ejector Bar fits through a slot in the ram below the Retraction Pin and spring. The head or lower end of the internal punch rests on the bar when the ram is being lowered. The bar comes to rest on the base plate. As the ram continues down, the bar and punch are held in position and push the bullet out of the die.

The height of the K.O. Bar and the length of the internal punch are a constant. Short punches use long K.O. Bars and vice versa, in the hand presses. Power presses have adjustable ejection points and use just one height of K.O. Bar for all punch lengths.

CHP-1 Hydro-press^{tm}

CHP-1 Hydro-press^{tm} Mark V with dual dwell timers (top and bottom of stroke). First shipped in early 2004. Previous model Mark IV used one dwell timer at top of stroke only.

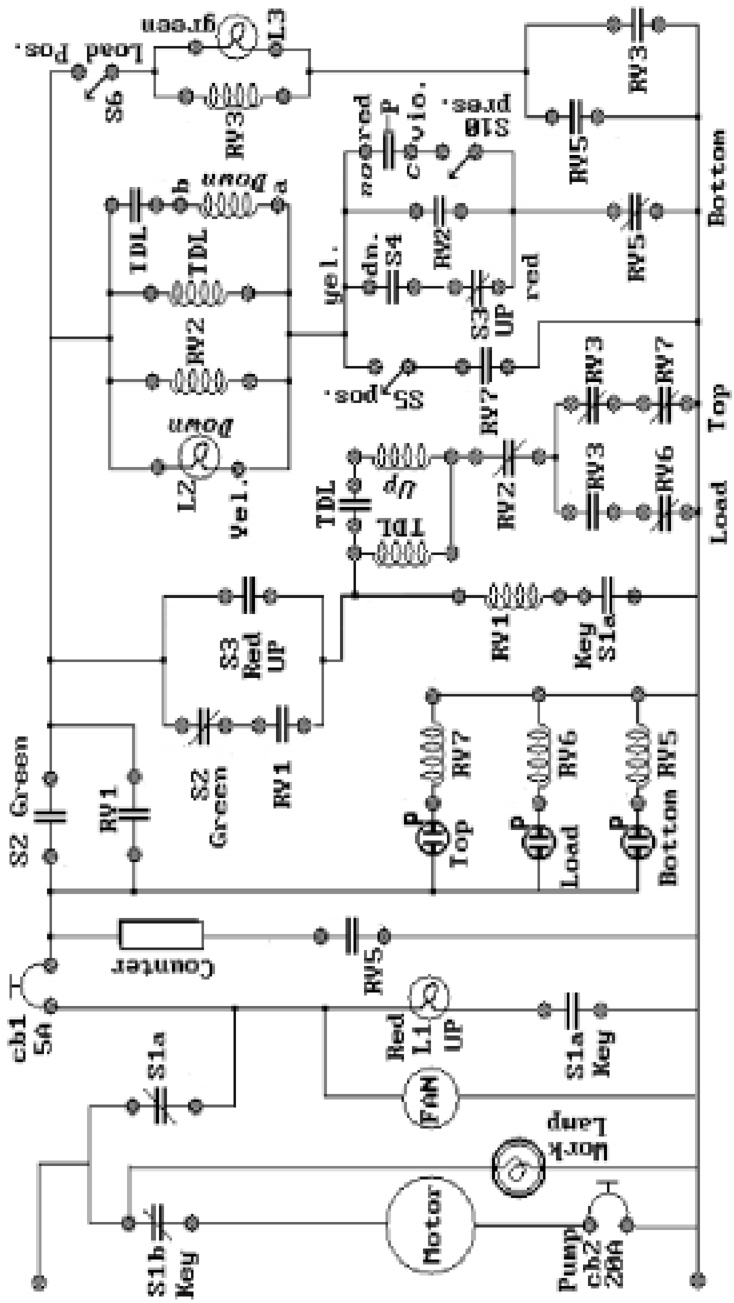
Shipping weight	350 pounds.
Floor space	22 by 15 inches.
Height press head	57 inches.
Height to control panel	34 inches.
Hydraulic fluid	Chevron AW 46, six gallons
Max. ram velocity	2 inches / sec.
Drive cylinder diameter	3-1 / 4 inches.
Maximum drive pressure	2,000 psi
Drive pressure range	100 to 2,000 psi (factory max)
Dual range pump	500 psi switch point (aprox)
Power options	120v 20a peak, 240v 10a peak
Idle current draw	5 amps @ 120v, 2.5 amps @ 240v
Position sensors	top, load (middle) bottom set
Work lamp	115v standard base

CSP-1H Hydro Mite™

CSP-1H Hydro Mite™ swaging and reloading press.
Self-contained, 5/8-24 threaded ram.
Press head uses 1-1/4 x 12 bushing to 7/8-14 thread.
Special optional bushing used for reloading die/shell holder.

Shipping weight .... 200 pounds.
Effective Floor space .... 30 by 52 inches (incl. overhangs)
Actual Floor space .... 22.5 by 40 inches (base)
Height press head .... Adjustable
Hydraulic fluid .... Chevron AW 46, 2 gallons
Max. ram velocity .... 4 inches/sec.
Drive cylinder diameter .... 2 inches.
Maximum drive pressure .. 2,000 psi
Drive pressure range .... 100 to 2,000 psi (factory max)
Power options .... 120v 14a peak, 240v 7a peak
Idle current draw .... 3 amps @ 120v, 1.5 amps @ 240v

CHP-1 Mk.V Wiring Diagram



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