AP Physics 101

A practical guide, with real world results

by APAnon

Made in collaboration with several anons, brainstorming and testing methods of AP manufacture that can be done at home, with minimal cost and experience required from your average /k/ anon.

1. Disclaimer

The author of this document take no responsibility for the actions of others. This document is for educational and research purposes ***only*** and we are not responsible for the actions of any individual who follows the information in this guide.

We are aware that we are not the first to come up with the concept of homemade armor piercing ammunition. However, we feel as if it is in the general interest of all anons that methods of producing effective and reliable AP ammo on the cheap be available to all, on a purely theoretical level, of course :^)

Before investing the time and money required for this project, please note that your results may vary™. We cannot guarantee that your specific gun, caliber, or core design will result in a level IV defeating round without significant engineering and testing. However, A properly designed round should prove to be far better than anything you could realistically get your hands on, for a fraction of the cost.

We plan to update this guide in the future as more testing and prototyping leads to better procedures and core designs. As such, we welcome any feedback from any anons that are familiar with machining and/or ammunition design, as we are certainly no experts ourselves. If you would like to reach out to us, you can email our throwaway proton mail address: APAnonOfficial@protonmail.com. We will also be maintaining a static archive at http://apanon2dq5gekdwbclgzex5bdidljxk2577gatdhfgoapl242dznd6qd.onion/ for future updates to our guide.

2. Is this legal?

The answer, like with all things regarding the ATF, is *it depends*.

Armor piercing ammunition is defined as follows:

"(i) a projectile or projectile core which may be used in a handgun and which is constructed entirely (excluding the presence of traces of other

substances) from one or a combination of tungsten alloys, steel, iron, brass, bronze, beryllium copper, or depleted uranium; or

(ii) a full jacketed projectile larger than .22 caliber designed and intended for use in a handgun and whose jacket has a weight of more than 25 percent of the total weight of the projectile."

What this means is that as long as your AP round is not considered a "handgun" round, then it is not legally armor piercing ammunition and is therefore not illegal.

However, this is the ATF we are talking about, so there is some sort of confusion on what "handgun ammunition" really is, as there is a history of the agency arbitrarily determining some rifle calibers, notably m855 green tips, to be a handgun caliber, despite primarily being used in rifles.

So who's to say that the ATF won't call your .338 Lapua a "handgun" caliber and throw you in prison?

In other words, err on the side of caution and assume that this is about as legal as that lightning link that you totally didn't make that one time in minecraft. (Do ***Not*** talk about AP club. **Keep it quiet, keep it safe and as legal as you realistically can, and for god's sake don't ruin it for the rest of us.**)

3. Acknowledgments

For obvious reasons, we're not going to be directly acknowledging anybody by name, so we'll instead thank all of the anons out there that have helped put this guide together. You know who you are, and we appreciate your efforts.

4. Introduction to Concepts

In order to avoid too much of the many complicated physical interactions between armor and a projectile, we will instead focus on a few rules of thumb when it comes to penetration and performance.

The first rule of thumb is that speed is king. The total kinetic energy of the projectile is given by the equation $\frac{1}{2}MV^2$, which means that the energy increases linearly with mass, but exponentially with velocity. Thus, a projectile that weighs half as much but travels twice as fast will have double the kinetic energy. Ergo, we want our projectile to be (relatively) light but dense and fast as opposed to heavy and slow, within limits.

Important also to consider are hardness and sectional density. Hardness, so that our projectile can effectively penetrate through hardened steel and ceramic armors without deforming or wearing, and sectional density, so that all of the available energy can be focused onto a single point to punch through steel and shatter ceramic plates, instead of spread out over a large area.

Another important thing to keep in mind is that projectiles that are too small and light bleed off too much kinetic energy as they travel through the air, while heaver ones will retain more energy by the time they make it downrange.

These variables must be balanced in order to produce an effective armor piercing round. Too much or too little of any of these things can throw everything out of whack.

Something unrelated to armor penetration but just as important for you to consider is stability in flight. Your round must be as axially symmetric as possible for rotational stability, and you must also balance the center of gravity and the center of pressure. The closer they are the better, but a bullet that is rear heavy is more unstable than a bullet that is more front heavy. Think a shuttlecock in flight.

Further reading on all of this can be found online, and would be pointless to try to condense into a few paragraphs. Do some proper studying before undertaking this project

5. Required Tools

One of the design goals for this project is to enable anyone with a basic set of tools and a little bit of cash to produce effective armor piercing ammunition. In order to make AP available for everyone, we have developed multiple methods depending on your skill level and tools available.

Tools you will need include a drill press, a vice and/or a second drill chuck, files (basic steel files and optionally a diamond file), and a hacksaw. If you have access to a lathe, that is preferable to a drill press.

PPE equipment and a basic understanding of common sense is, of course, always recommended when working with heavy machinery and/or lead.

And, of course, in order to actually load and fire your homemade armor piercing ammunition, you will need all of the required reloading materials. If you have never reloaded for your chosen caliber before, it is recommended that you reload standard bullets in order to get a good idea of how to reload properly and safely, before reloading any homemade ammunition.

6. Where to Acquire Tools

All of the tools required can be found at your local hardware store, although be aware that you will get what you pay for, and every little bit counts with this kinda precision machining, so don't skimp out if you don't have to.

The type of drill bits we recommend are stubby bits with a hexagonal shank. A shorter drill bit will handle torsional loads better than a longer one, and since we are working with softer metals, you will likely experience quite a bit of that (More on this later). And a hexagonal shank allows you to tightly secure your drill bit in a vice or chuck.

For a vice, we recommend a drill press vice. If you chose instead to use a drill chuck, this can also usually be found at your hardware store, and can (usually) be mounted to the center hole of your drill press plate with a bolt and washers.

7. Material Acquisition

The core material of choice is tungsten carbide, as it is extremely hard and dense, which are of course two of the most desired traits of an AP penetrator. Combining these with a copper/lead "sabot" made from a standard bullet allows us to maintain a relatively light projectile without sacrificing on the aforementioned hardness and sectional densities. Sourcing tungsten carbide can be done in a number of ways, the quickest and easiest method would be to search for "tungsten carbide rod/needle" or similar on Alibaba (Fuck china, but they're the only ones that will make tungsten carbide cores for a literal nobody). A lot of the sellers will allow for custom orders, but be sure to shop around in order to find the best deal. If you have access to diamond grinding tools, you can source whole rods from McMaster Carr or similar, and grind them down to size yourself.

NOTE: DO NOT MENTION BULLETS, AMMUNITION, FIREARMS, OR ANYTHING ELSE RELATED TO GUNS WHEN CONTACTING SELLERS FOR CORES. THINK BEFORE YOU SPERG, IF THEY ASK YOU WHAT THEY'RE FOR, MENTION METAL SCRIBE PENS, GLASS BREAKERS, OR ANY OTHER PLAUSIBLE USE THESE CORES WOULD HAVE THAT DOESN'T INVOLVE GUNS OR AMMO.

The following dimensions are the general guidelines we have been using to develop our core designs. Keep in mind that there is not one "correct" design, as you must take into consideration your own design goals such as weight and velocity, tip angle, etc. However, we will include a few known designs below.

30 caliber (.308/7.62mm):

- core diameter 4mm to 4.76mm (3/16")
- tip angle of 30° to 60°
- overall length 20mm to 27mm

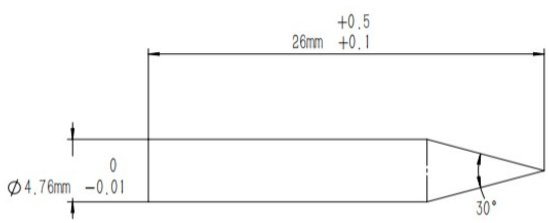
22 caliber (.223/5.56)

- core diameter 2.5mm to 3.5mm
- tip angle of 30° to 60°
- overall length 10 to 15mm

Typical designs

heavy .30-06 penetrator:

diameter 4.76mm (3/16"), overall length 26mm, tip angle 30°

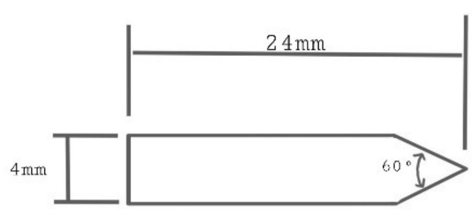


Exposed tip penetrator with a larger, heavier core.

loaded into a boat tail bullet for an average weight of 175-200 grains and a velocity of ~2,750 fps, this round hits hard and fast

lightweight .308 penetrator:

diameter 4mm, overall length 24mm, tip angle 60°

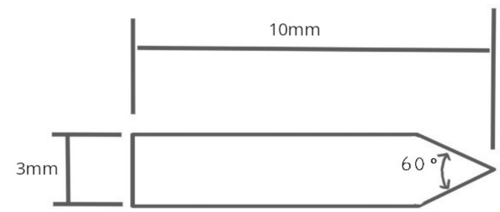


Enclosed penetrator design, with a smaller, lighter core.

Loaded into a boat tail, this produces a lighter round with an average weight of 125-150 grains, more suitable for a .308.

.223 penetrator:

diameter 3mm, overall length 10mm, tip angle 60°



Enclosed penetrator design with a smaller, lighter core suitable for small, fast calibers

loaded into a boat tail, this round is less capable than the larger calibers, but still packs a punch.

The base bullets that you will be drilling into depends on the caliber and procedure you have chosen and, again, depend on your desired design characteristics. For the base drill bullets we have selected m80 bullets for the .30 caliber design, and M193 bullets for the .223 design. Another option to consider are solid copper bullets, as they are lighter, and can be machined more precisely

Depending on how tightly your cores fit into the bullet, you may also require some sort of binding adhesive to secure your core in place. We recommend loctite, super glue, or JB weld.

8. Procedures

These following procedures use a simple setup utilizing a drill press, with either a drill press vice or a second drill chuck (referred to simply as the "vice" form here on to avoid confusion with the drill press chuck) mounted flatly onto the work plate and centered with the press chuck. We recommend mounting the drill bit in the vice, with the work piece (The bullet) mounted in the chuck, as this makes the process easier on us (i.e. de-burring and filing the bullet in the drill press instead of taking it out to file/sand, clearing shavings from the bore easier, etc)

Base Drill Method

The base drill method is the preferred method for those who want an easily concealable AP round that is 100% safe to use in any weapons (including semiautomatic/automatic fire) with minimal steps, but may incur minor penetration and stability penalties. (i.e. better for semi auto AP, not as much for long range precision shots)

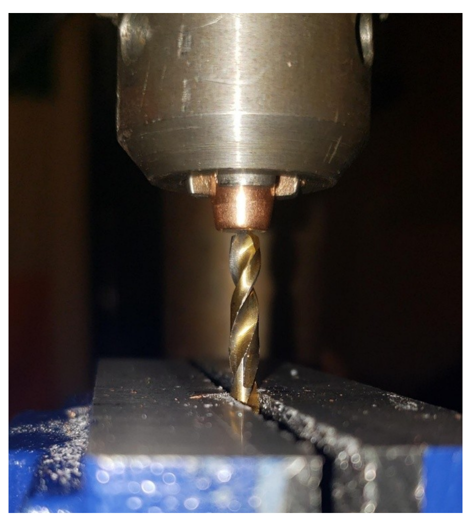
Step 1: Prep

We will start off by prepping our setup for the drilling procedure. This can be a bit time consuming, so we recommend doing each step in batches to avoid any unnecessary tool change outs and realignments. First, we must mount our drill bit in our vice, making sure to keep our bit as vertical as possible. If using a drill press vice, we can use the chuck to grab the drill bit and hold it steady while we clamp down with the vice. If using a second drill chuck mounted to the center hole of the plate, this step should be unnecessary as it is already more or less in line with the drill press.

In order to make fine adjustments, you can use a rubber mallet to tap the vice/chuck around, bringing the drill head down to visually inspect the centering of the drill bit with (the tip of a bullet, the center of the drill chuck, a penetrator core mounted in a drill chuck, etc).

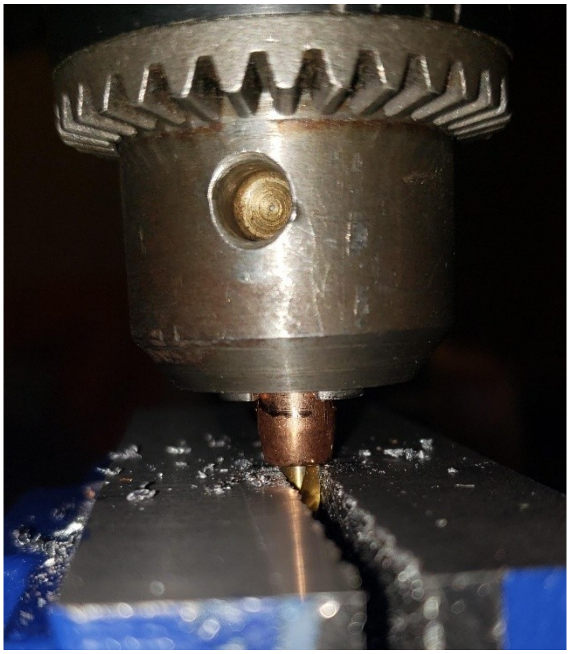
Making sure that everything is centered up properly is extremely important. Remember that these bullets will be spinning at several hundred thousand rpm, so concentricity is key. Double check between every bullet that things are still lined up.

Step 2: Create a center hole

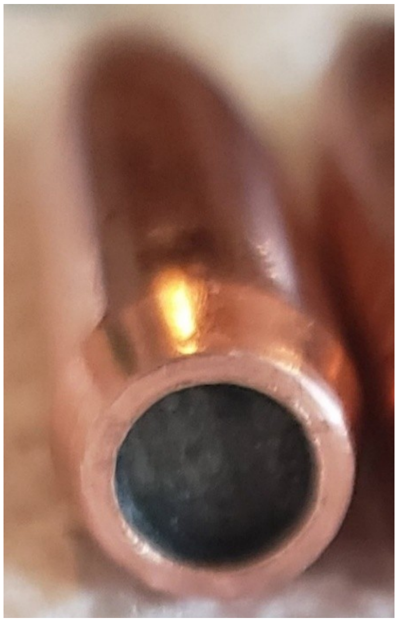


With our bullets mounted in the drill chuck, Start by creating a center hole in the base of the bullet with a drill bit. You may attempt to skip straight to the final sized drill bit in order to save some time, but if you're having issues with bore concentricity and/or the drill bit walking, making an initial center hole with a smaller diameter drill bit will allow the larger bit to index and avoid walking. (repetitive, we've already recommended a drill bit in the materials section). This will create the initial center hole that we will be using to drill out our final bore. If needed, you can watch this video for a guide on doing this: https://youtu.be/KYFQB_CG64A

Step 3: Drilling



Now for the fun part, but take it slow. This is the hard part, and a few things can go wrong here if you try and drill too fast. Begin by drilling through the first few centimeters. For the first few rounds you may want to stop here and check your concentricity both visually and with a pair of calipers, if you have them. If you are confident with this, you may continue drilling, taking a couple of small bites at a time and pulling back. This serves multiple purposes; to clear any metal chips from the drill flute, and to allow the drill bit and the work piece to cool. You can brush some cutting oil onto the drill bit at this time with a small acid brush, which gives extra cutting and lubricating action, cools down the pieces further, and also helps to remove more metal shavings from the drill bit.



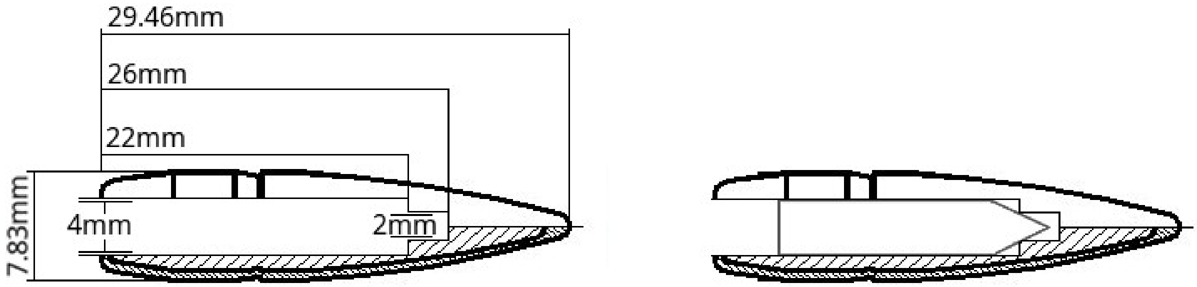
Be careful though, as copper and lead are both very soft metals, they can get a bit “grabby” if you attempt to drill to fast. This can result in the drill press seizing up or, in the case of a lead core bullet, can heat up and soften the lead to the point where it pulls away from the copper jacket, pulling out too much lead and ruining your bore hole.

In order to free up a seized bit, turn off the drill press and use the chuck key to work the drill bit back and force until it becomes loosened and frees itself from the bullet. If this is happening too often, it means you are applying too much force. If you want to speed up the process, cutting oil usually makes things quicker without putting more pressure on the drill. it.

Step 4: Drilling, part 2

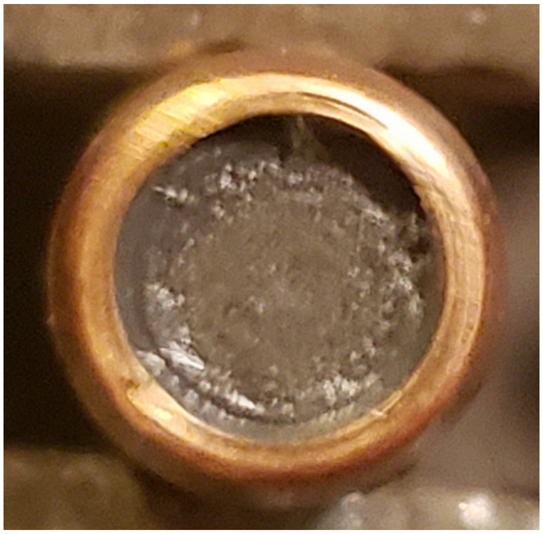
This part is optional, but allows you to seat the core further forward, which improves the center of gravity and stability of your projectile.

Once you've drilled your final diameter hole, replace the drill bit with a smaller bit, roughly half of the size of your final diameter, and drill a few mm deeper, to accommodate your core tip further up, where the bullet itself is narrower than the core diameter.



Step 5: tuning the weight

At this step, to fully tune the weight of your projectiles in order to improve accuracy, you can match the weight of the bullet to the core (as the cores will also have some variation in weight, themselves), removing any additional weight from the bullet with the drill bit in order to reach your desired weight.



Step 6: Fitting the core

Next, we will be using adhesives to secure the core into place using your preferred high strength adhesive (JB Weld, super glue, loctite, etc). One tip I would highly recommend is to *not* let the adhesive come into contact with both the core and the bullet until the last second, as you can have issues with the core bonding in place before you want it to (Like, say, when your core is still sticking out of the bullet half way). You can avoid this by either dropping a few drops of the adhesive to the bottom of the bore, without getting any on the walls (if you can), and inserting the core into the adhesive. Otherwise, you can insert the core about ½ to ¾ of the way in, apply glue to the remaining section of the core, and finish seating it.

Once your core is seated in place, you can cap off the back of the core with more adhesive/epoxy, or a metal plug if you want a heavier bullet, to fully secure the penetrator in place.

Tip Drill Method

The Tip drill method is the preferred method for those who wish to maximize the accuracy and penetration capabilities of their projectile. However, one must note that this method requires extra time and steps in order to render the ammunition safe to cycle in most guns, without hand feeding the rounds, as **an exposed tungsten carbide core will quickly and rapidly wear through your feed ramp, and any other parts that the core comes in contact with.**

Step 1: Truncating the tip

In order to prep the bullet for drilling, we must first remove any excess material at the tip by either cutting it off with a saw (a custom cutting jig can give flat, even cuts on such a complex shape), or filing it flat with a set of files, up to the point where the tip is at the same, or a slightly larger diameter, as the core. This gives us a nice flat spot to begin drilling, which will greatly reduce the chances of the drill bit walking, losing concentricity, and possibly snapping.

Step 2: Drilling

At this point we will be following **steps 1-3 of the base drilling procedure**, drilling out the tip instead of the base this time. Extra care and processing may be required at the rim of the bore, as there may be some slight bulging and burring of the copper jacket. This can be prevented by drilling slower for the first few millimeters until you the bullet becomes thick enough to resist deforming, or it can also be cleaned up by filing down any of the bulging and warping, and using a de-burring/countersinking bit to clean up the rim of the bore, giving us a nice, professional edge between the copper jacket and the core.

Step 3: Processing the core (optional)

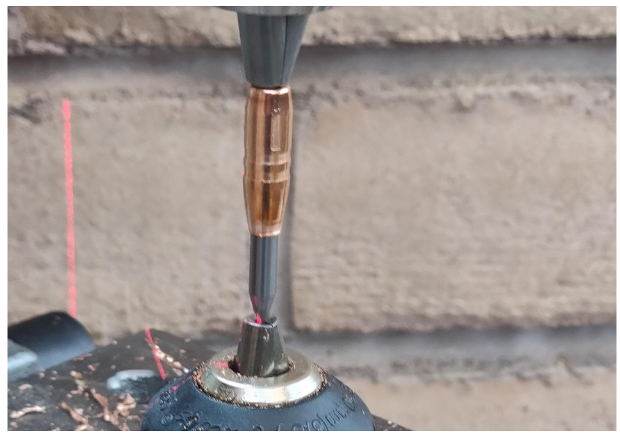
As I mentioned earlier, in order to chamber this ammunition easily without excessive wear to the feed ramps, we must go through a few extra steps in order to prep the core. For this step we must now replace the bullet in the drill chuck with our core, and use the diamond file (Which can be found in the tile section of your local home improvement store) to round out the tip of our core (to prevent the tip from digging into your feed ramp) and roughen up the edges of the point (for better adhesion of a protective layer at a later step).

You can also roughen up the circumference of the core at this time, for better adhesion of the core to the bullet when we seat it. This is especially recommended if you're planning on gluing the core in, as a rough surface is vital for proper adhesion.

Step 4: Fitting the core

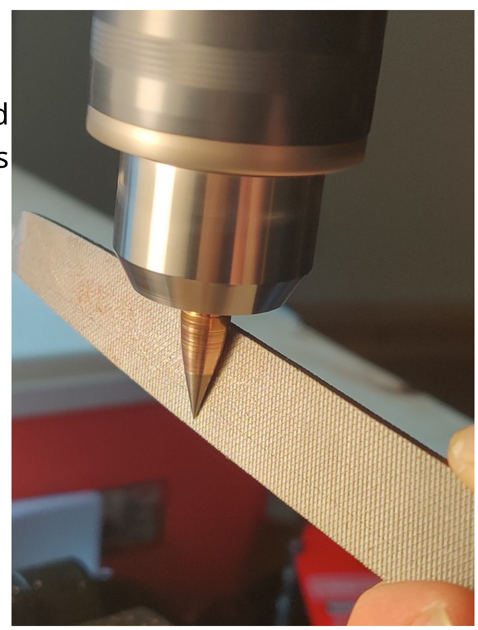
We are now ready to press the core of our projectile into place. If you cannot get the core in by hand, you may need to use a vice or your drill press to press the core into your projectile. If this is the case, gluing the core in place should not be necessary in the next step, as the friction of the core and the bullet will hold it in place.

If your core is too loose to be kept in place by friction alone, you can glue it in place using adhesives, using the same process as the base drill, squirting a bit of adhesive into the bottom of the bore, or inserting the core ½ to ¾ of the way in and then applying adhesive to the remaining portion and pressing the rest of the way in.



Note: you will want to press the core flush with the copper, or just a touch deeper. We can file away the excess copper to produce a smooth transition between the tip of the core and the jacket.

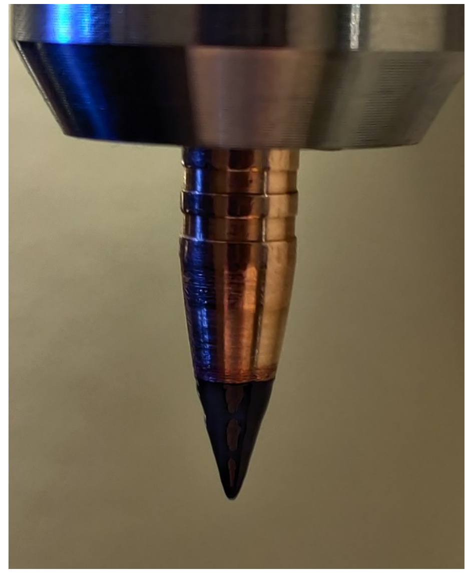
Step 5: Finishing



For the finishing touches we will filing down (and polishing, if you want that nice, sexy AP look) the excess copper jacket at the rim, to create a smooth, aerodynamic transition between the copper and the core (if it is necessary).

Additionally, if you want these rounds to feed into your gun without any excess wear to your feed ramps, you can dip or otherwise coat the tips of your cores in a hard enamel. Several layers of nail polish work for feeding through a bolt action rifle, although it has not yet been tested through a semi auto rifle.

Another possible method for protecting your gun from excessive wear and tear is to punch out a small metal disk of aluminum from an empty soda can (like with a paper hole punch, for example), and using some sort of press to stamp the aluminum disks into protective caps that can be glued onto the exposed core. This method has not been tested yet however, and it is unknown how this layer of aluminum might affect the flight characteristics of your projectile. Nevertheless, it is a good method to consider as it may require less time and effort over an enamel coated projectile.



Molten lead method

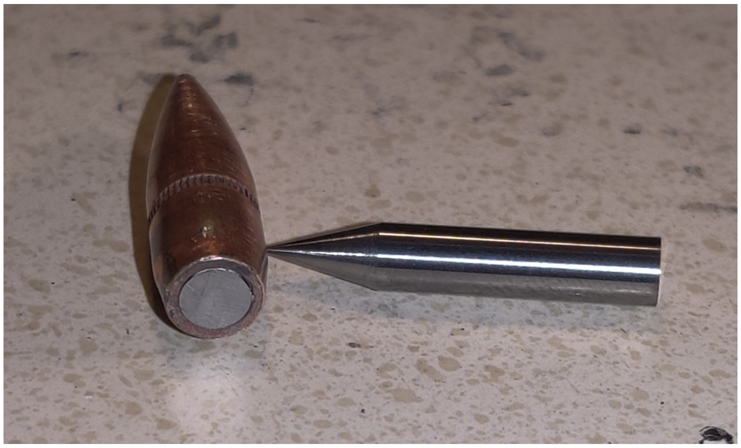
This is the first method that I tested, back when it was just me. You may recognize this method if you have seen the first video I produced.

By far the easiest and least expensive way to produce AP ammo, requiring not much more than a propane torch and some pliers, but also the least accurate due to inherit instability in the design. Has a small (~10-15% for the second test batch) chance of tumbling. Core size is more restrictive due to how the core is held in place. We would recommend another design, but will be including this for informative purposes.

Step 1: Core design

When designing this round, careful consideration must be taken in order to hold the core in place while the lead is still molten, as the core can shift and unbalance the bullet, causing your round to tumble as it travels through the air.

We can accomplish this by selecting a jacketed hollow point with an open base, similar to the design below, and utilizing the jacket to index the core both at the tip and at the base. The diameter and overall length of the core must be calculated such that the base sits flush and tightly against the copper jacket when fully seated in order to provide 2 points of contact.



Step 2: removing the lead

After you have chosen the appropriate bullet and core combination, we will first start by heating the bullet (while tip down, for obvious reasons) evenly with a blowtorch until the lead melts. When the lead is melted, we will dump it out into a bucket of water to cool down and solidify.

This step is necessary because during the pressing process, any excess lead will be forced out of the bullet between the copper jacket and core, and depending on the pressure could spray quite a distance from the bullet in a splash of toxic liquid metal. Obviously this is undesirable if you do not wish to get molten lead on you or anything surrounding you.

Step 3: Measuring out some filler lead

You will then measure out a predetermined weight of lead. You can measure out the stuff you dumped out earlier with a small scale, or you can also use some lead birdshot for easy volumetric measuring. The exact amount of lead will depend on your exact setup, but you want just enough that a bit of lead beads at the base of your copper jacket when the core is fully seated. In my case, it was roughly 30 grains of lead.

Too little lead can leave air pockets between your jacket and core, which may affect stability. Too much lead and it can run down the side of your copper jacket, potentially adhering to the outside of the copper jacket and becoming a pain in the ass to remove, depending on how solidly it bonds with the copper

Step 4: melting and pressing

Securing the copper jacket in some sort of clamp or other heat resistant holder (A small wrench socket works well), begin heating both the copper jacket and the penetrator core with the propane torch, until the lead in the copper jacket melts.

When everything is heated to temperature, you can use a pair of pliers to pick up the core and insert it into your copper jacket, pressing firmly but gently to make sure that the core is fully seated as far into the jacket as it will go.

Step 5: Finishing

Once your projectile has cooled down enough, it can be cleaned up with some copper polish to remove the discoloration caused by the heating and weighed to determine the final projectile weight, but otherwise should be ready to load as soon as it is cool to the touch.

9. Alternative core designs

Several alternative core designs have been created, and are in various stages of testing and design.

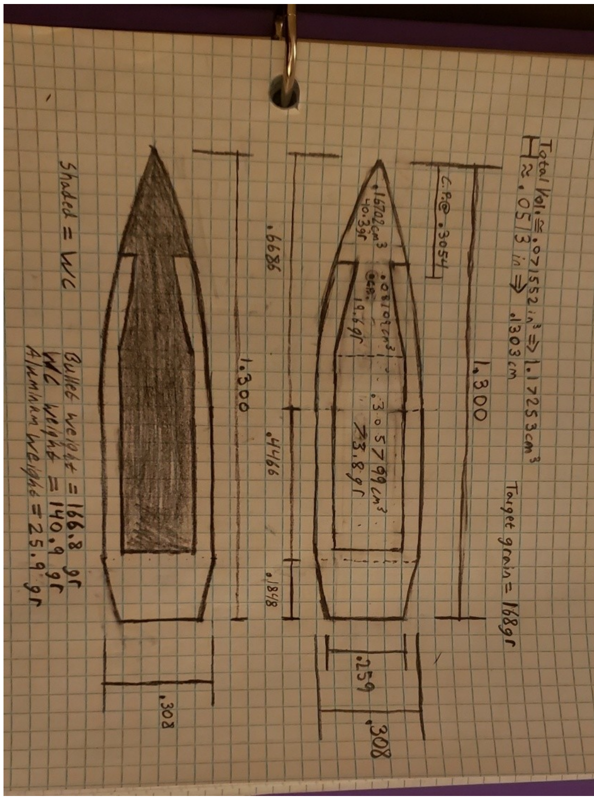
Arrowhead core design

A derivative of the tip drill method and inspired by the M1158 ADVAP, this design uses an arrow shaped core with a stepped down shaft diameter. Characteristics of this core are similar to or better than the standard exposed tip penetrator, with the added benefit of being less challenging to drill out the smaller diameter bore for the shaft.

Downside is cost, as the core is more complex than the standard core design. Very interesting core design, nonetheless

Crimped core design

Inspired by the design of rounds such as the M855a1 and M80a1, this design uses a crimped core instead of the standard straight walled core. Untested as of yet, but should provide increased performance over the standard design. The downside is that it requires a lot more investment in the hardware used to manufacture the bullet, including crimping/swaging dies and presses, as well as the cost of the cores themselves.



10. Additional considerations

Additional design considerations may be taken in order to optimize your projectiles to your own design goals.

Scaling between calibers

Scaling between calibers can be done quickly enough with careful consideration of the new caliber’s characteristics, and how the higher density core will affect the performance of your projectile. for instance, a 180 grain lead core projectile can have it’s mass increase to 200 grains or more due to the higher density of the core material. This round would not be optimal for a .308 Winchester due to lower velocities, would preform better in a .30-06, and even better in a .300 WM, which can drive a 200 grain bullet to very high velocities in excess of 3,000 ft/s.

You will generally want to select core dimensions in sane and rational dimensions, so that you’re more likely to find someone with existing stock that can be modified to fit your needs. Getting someone to grind a tip onto a 3mm round carbide rod is a lot easier than having them custom make a 3.420mm diameter rod because reasons. This should be obvious enough for most people

Alternative core materials

While we chose tungsten carbide due to it’s considerable performance and ease of purchase, there are several additional core materials that can be considered due to their high density, high hardness, etc. Below is a short list of materials we have considered for use in an AP core. Note, however, that we still recommend tungsten carbide due to the performance per dollar.

When looking for alloys, I would recommend looking at what options you have online for round stock material or what people already manufacture on Alibaba (or a US supplier, because fuck china.) It’s much easier to get someone else to make it for you for $1/round extra if you don’t have the money to invest in expensive tools and the like.

“”””””””””Legal”””””””””” core materials:

- UNS R30035 / MP35N:

33-37% Ni, 19-21% Cr, and 9-10.5% Mo, small additions of Ti and Fe (1% max each), C, Mn, Si, P and S (all less than 0.15% each). Co is the balancing element (around 33%)

High strength, toughness, and ductility.

- Nimonic 90:

Ni 54%, Cr 18-21%, Co 15-21%, Ti 2-3%, Al 1-2

- Titanium carbide

TiC is very porous, making it a good option to consider for a coated core design in order to prevent additional wear to your gun.

- Boron Carbide (sacrificial tip penetrator)

B4C is extremely hard, even harder than WC. However, it is nowhere near as dense, coming out to 2.52 g/cm^3 instead of ~14.07 g/cm^3 like our grade of tungsten carbide.

Can be used as a tip to crack armor with the mass of the lead behind it transferring it's energy through the hardened tip

- Any other material that does not contain "banned" core materials as defined by the ATF.

Less Than Legal core materials:

- Other compositions and grades of tungsten carbide.
- Tool Steel, or any other flavor of hardened steel

  not as good performance but very easy to make your own cores in the garage

- Depleted Uranium (lol, good luck with that though)
- Tungsten heavy alloy (WHA)

  Metallic tungsten alloy, as opposed to cemented tungsten carbide. Not as hard as a carbide, but it's still fairly hard, less prone to shattering, and as much as 30% more dense than the carbide.

Multi-core penetrators

As the name implies, multi core penetrators are designs in which multiple discrete core segments are stacked on top of each other in order to produce a longer, more substantial core. The idea behind this is that when your projectile hits an armor plate, the ceramic core can dull, crack, or shatter, leaving it unable to penetrate any further armor plates. A stacked core, however, would see the first core shatter, leaving a second and possibly even third core behind it that can go on to further penetrate any remaining armor.

The interface between these core segments can either be a simple flat face for ease of manufacture and lower cost, or a conical interface design that may help with transferring forces between the multiple cores and would leave a nice, sharp point after the first core breaks.

11. Continued Development

As mentioned above, if there is sufficient interest from anons this guide will be updated as time goes on. Any feedback on the guide itself or any improvements is appreciated, and the more anons that are testing their own homemade AP ammunition the better. Images and videos that show the process or results are also welcomed. Make sure to cover your ass though if you do, don't need to have the ATF come knocking.