Contents

COVER STORIES

OTHER FEATURES

REGULAR

PROMOTIONAL ARTICLE

78 HUNTING IMAGES

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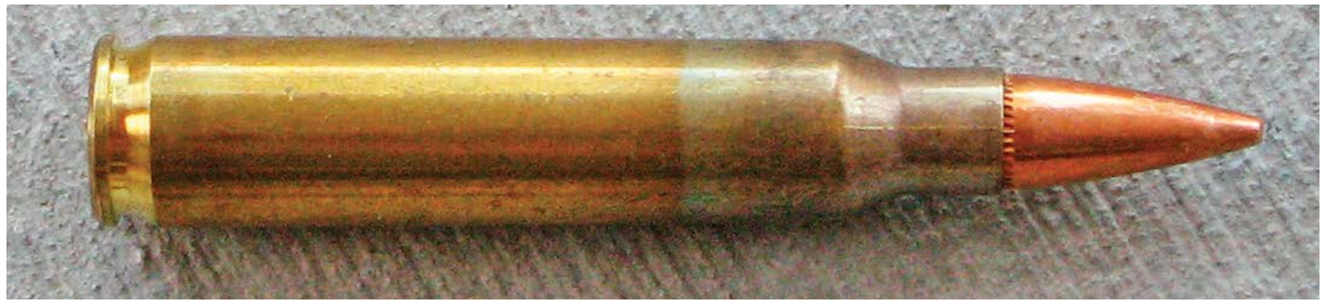
Chris Bekker

ANNEALING YOUR BRASS

There are no hard and fast rules – it depends on the judgment of the reloader.

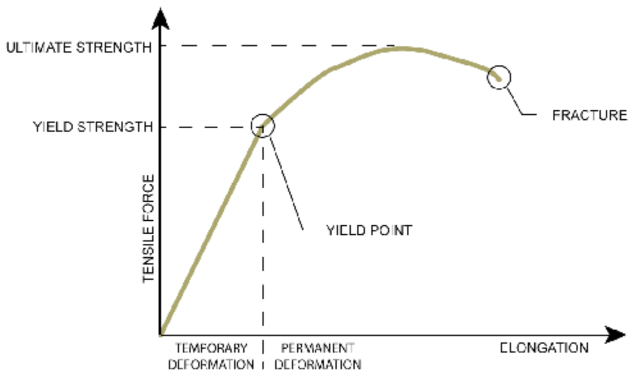


Discolouration on the neck and shoulder due to the annealing process

Few handloaders ever bother to anneal their brass and the few that do are usually dyed-in-the-wool shooters who are involved in some form of competitive shooting as opposed to the hunter that does not fire so many rounds. There is good reason for this though. Until recently, annealing cartridge brass was at best a spotty proposition – the brass is either over-annealed or under-annealed. Annealing brass is also time-consuming if you do not have mechanical equipment and have to do it by hand, one at a time. Some shooters using benchrest rifles claim that it actually does very little for accuracy.

Some basic principles about brass as a metal

Cartridge brass is a ductile metal with mechanical properties like strength and elasticity. We can test materials to determine the values of those properties and to see how these materials behave under different circumstances of force applied. This is best described by the below diagram that is self-explanatory:

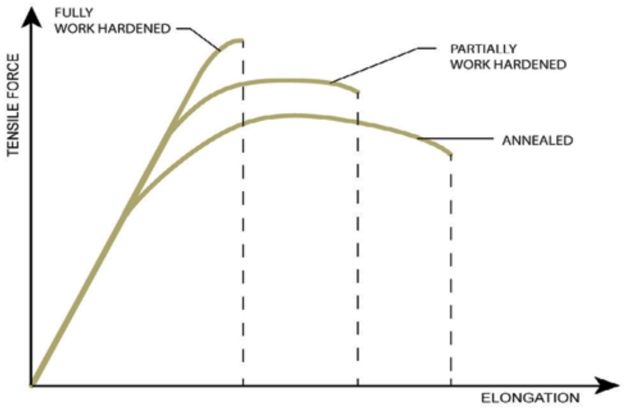


Behaviour of ductile metal under tensile force

When the brass snaps back to its original size we refer to it as **elastic deformation**. At some point of force applied you will hit the **yield point**, which indicates the point at which the metal will no longer return to its original shape. Beyond this point the brass will reach a stage of permanent deformation known as **plastic** deformation, which refers to the metal's yield strength. The yield strength is expressed in units of pounds per square inch, but it is not the same as chamber pressure. In engineering terms the word **"hardness"** is an equivalent concept to yield strength. When more force is applied, it will fracture and break into two pieces. The maximum force you can apply without breaking the metal is referred to as the **ultimate strength** of the material.

Work-hardening

Hardness means yield strength. Each time you fire a case, it work-hardens a little more and gets a little **stronger**, but its elongation ability is compromised. The diagram below demonstrates what happens when brass is annealed:



Effect of work-hardening on brass

In the annealed state the strength of the brass is at its lowest, but it has a high ductility – i.e. the metal will stretch a long way before it breaks. Conversely, when the brass work-hardens, its ductility will lessen, and at some point it will become brittle and break – at this stage cartridge brass will manifest neck splits.

The need for annealing is related to how "hard" the brass becomes

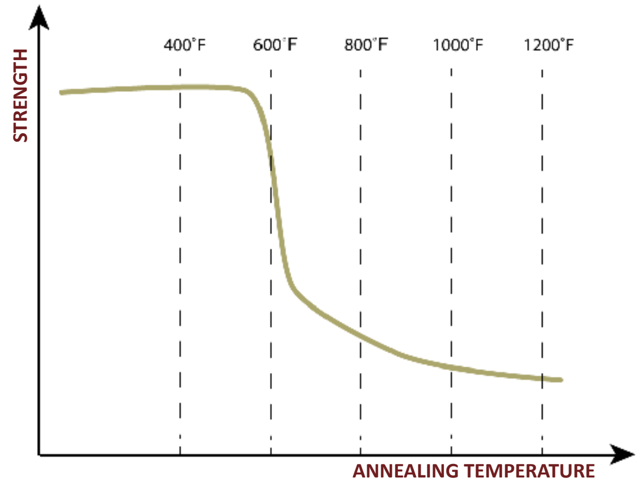
The good news is that work-hardening of cartridge brass is reversible. The heat applied will cause the grain size of the metal to increase at the microscopic level, thereby becoming softer and regaining its tolerance for stretching. Annealing therefore is a simple process of applying heat to the case necks to eliminate any brittleness that has built up over time, and to restore the case's natural resilience. Overheating of the necks will make the brass too soft. Proper annealing is a matter of temperature and time.

There is no hard and fast rule as to when one should anneal a cartridge case; it depends on a few factors that may work in conjunction with each other that may cause you to anneal quicker than the general rule of thumb of every fifth reload. The number of firings therefore do not tell the whole story:

- The size of the chamber relative to the loaded round. If you have a "loose" chamber you will expand your brass more. It will need to be squeezed more when it is resized, thereby causing it to be worked a little more than "normal".
- How "hot" the reloads are in relation to the operating chamber pressure. Hot loads in factory chambers may require annealing more often (about every three firings).
- In "tight" chambers in target and benchrest rifles many more firings can take place without the need for annealing.

Annealing temperature

Annealing for cartridge brass happens at around 650-700 °F. If you apply a higher temperature, the brass will get even softer, as illustrated by the below diagram:



Effect of annealing temperature on brass strength

There is no reason for heating brass (case necks only) beyond 700 °F as the desired effect has been achieved at that point. The case body should never be annealed but should stay hard. To control the temperature of the cartridge case, Tempilaq (a special kind of "paint") is used, which is designed to melt at a very specific temperature. Use some 475° Tempilaq on the case body to make sure it does not overheat, and some 700° Tempilaq on the neck to make sure it reaches the required temperature. To anneal brass, all that is required is heat and time. It is a myth that brass needs to be quenched, as it relates to steel that exhibits different annealing properties.

Automated annealing

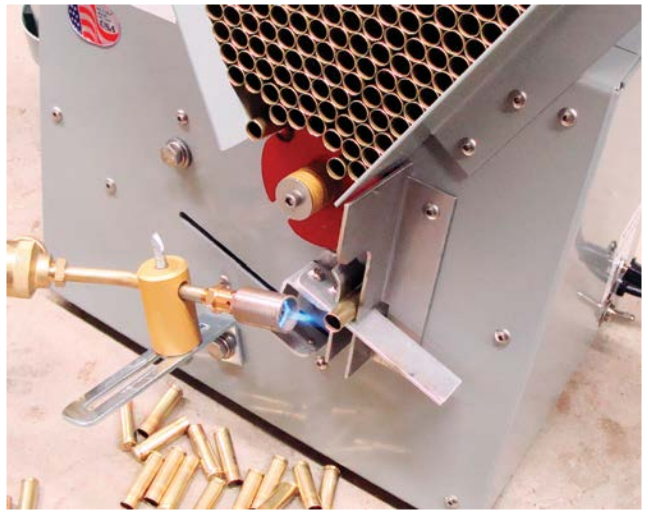
Today we have the luxury of automated annealing if you are willing to spend some money to assist you with this laborious task. However, some experimentation is needed to achieve the following:

- Control the time or duration that the case neck will be heated.
- Control the intensity of heat delivered to the case neck.
- Revolve the case at a constant rate during heating so that heat is applied evenly around the neck.
- Prevent or sufficiently limit heat conduction into the case head.
- Cooling off the brass in a water bucket so that it can be handled.

Jim DeKort home-built automated annealing machine

Some practical tips

- I suggest that brass be tumbled so that it is clean and polished before being annealed.
- If you do not have a tumbler or polisher, use a little Brillo on a soft cloth and turn them by hand.
- "Decap" or "deprime" your brass before annealing it.
- Brass does not require any special preparation before annealing. However, you will need a few polished cases in order to determine the correct temperature.
- Every torch flame will vary in intensity. You therefore have to experiment to get the right temperature.
- Some auto-annealing machines have two flames instead of one, reducing the annealing process by half.
- Case size also plays a role in the temperature that the case takes on, e.g. a .223 Rem case versus a .416 Rigby case.
- After annealing the cases, do make sure that they are dry before sizing is done.
- The expansion and contraction of annealing does have an effect on the case length. You should therefore first anneal before sizing and trimming the cases to the same length.
- The cases should be cleaned after annealing to get rid of the Tempilaq.
- You may wish to polish your cases after annealing with an electric drill and steel wool to remove the brownish colouration caused by the annealing process to make them look like new.



The Giraud Tool Company annealing machine

Since brass is an excellent heat conductor, a flame applied at any point on a cartridge case for a short time will cause the rest of the case to heat up very quickly. Brass that has been "work-hardened" is unaffected by temperatures up to **482 °F** regardless of the time that it is left at this temperature. At about **495 °F** some changes in grain structure begin to occur, although the brass remains about as hard as before. The trick is to heat the neck just to the point where the grain structure becomes large enough to give it a springy property. The critical temperature at which the grain structure reforms into something suitable for case necks is **662 °F**.

Obtain some 475 °F and 700 °F Tempilaq. Paint the **475 °F Tempilaq** about 5 mm away from the shoulder on the body of the case. The **700 °F Tempilaq** is used for the neck area. When the Tempilaq changes colour on the neck area, the neck will have a temperature of between 650 and 700 °F. Do make sure that the 475 °F paint is not melted on the body of the case to ensure that the body has not been overheated (annealed).

With experience you can detect a change in shine/dullness and a slight colour change when the temperature is correct. I suggest learning with Tempilaq paint. When the case turns to an orange glow, it is too hot (around **950 °F**) and the brass will be too soft. The neck area then becomes too weak again to grip the bullet as tightly as it should. (Watch this YouTube video to get a good idea of brass colouration [when it is overdone and when it is just right] if you do not want to use Tempilaq to guide you: https://www.youtube.com/watch?feature=player_detailpage&v=filrLvAUh6o#t=86)

It stands to reason that one will get a more consistent result when using an automatic annealing machine, such as the one made by the Giraud Tool Company that is commercially available. This machine features a built-in propane torch head to heat the case, anodised aluminium rollers to feed the cases, and a sliding tray that spins the case in front of the flame for a user-settable period of time, after which the sliding tray will drop the case out of the machine. The convenient part is that this machine has a "hopper" that can hold several hundred cases. Once it is properly set up, it can run automatically while the process is being watched.

Like any automated process, the set-up of the machine is critical. The important parameters are the size and position of the flame, and the amount of time that the case stays in the flame. According to the instructions, the inner blue flame should be ½" long, with its tip located ¼" away from the case neck. Always follow the recommendations of the manufacturer. For example, for proper annealing of .30-06-sized cases the manufacturer recommends that the case necks be exposed to the flame for eight seconds. It can be set with a stopwatch and the adjustable speed control on the side of the machine. Proper annealing is a matter of temperature and time and it may require some experimenting to get the right balance. A 1 lb bottle of propane can anneal thousands of cases.

The biggest advantage of this machine is its ability to run with minimal user "intervention". Once you have determined the right dwell time for your cartridge type, you can stack hundreds of cases in the V-shaped hopper, turn on the torch and let the machine do its thing. With a typical eight-second dwell time, the Giraud annealing machine will process about 450 cases per hour.

In conclusion

Annealing is a simple process of applying heat to the case necks to eliminate any brittleness that has built up over time, and to restore the case's natural resiliency. When a case neck is annealed, some of the hardness and springiness is removed from the neck and shoulder area to allow the case to provide more consistent neck tension, and to better seal the chamber upon firing.

Depending on chamber tolerances and the degree of expansion that the case neck has to undergo, the frequency of annealing can vary greatly from factory chambers to benchrest chambers. As a rule of thumb annealing is suggested for every fifth reload when fired in a mass-produced factory rifle and when being full-length-sized every time. Regardless of calibre or pressure, it is wise to always anneal every so often if you want the maximum use out of your cartridge cases. It is not uncommon for benchrest shooters to get 20 reloads from their cases and in some recorded cases on reloading forums double that number of reloads. Precision reloading calls for keeping meticulous records and serves as a reference point for future reloads, so do keep a master record binder for each of your rifles.

Do not let your wife catch you out by asking you if you have done a cost/benefit analysis after you have bought the annealing kit to get you started. You could play dumb though and ask her what she really means as you have never heard of such a thing when it comes to spending money on a hobby ... Let's see what a simple cost/benefit exercise looks like; for simplicity's sake the cost of the consumables (gas and Tempilaq paint) is ignored:

Cost per cartridge case = R12
Assumed number of reloads = 20 times
Assumed number of reloads without annealing = 5
Assumed incremental reloads are thus 15

Cost per case = R12.00/15 = R0.80
Number of shots p.a. = 1 200 rounds
Cost per annum of cases = 1 200 x R0.80 = R960
Cost of annealing machine = R4 400
Payback period = R4 400/R960 = 4.6 years

If your wife knows that you are actually only shooting 300 rounds per year (four times less), you may find yourself in a precarious position with a payback period of 18.4 years, which she will not see as a good return on investment! She may prefer to spend the money on a family holiday instead ...

If however you happen to be a PH or a guide at a lodge and have a big-bore cartridge with cases costing R42 to R56 each, and you shoot around 120 rounds per annum (ten rounds per month), the math changes somewhat in that the cost goes up, ranging from R5 040 to R6 720 in respect of a .416 Rigby and a .450 Rigby. You could then throw your wife a curve ball and tell her that you plan to be in this game for at least the next 30 years, and that the capital cost of the annealing machine is a one-time investment, that the cost of cases will escalate at least by 8% annually, and seeing that she is so darn clever, you would like her to do a **"Nett Present Value"** (NPV) calculation for you over the 30-year period. And while she is at it, just for good measure you would also like to know the **"Internal Rate of Return"** (IRR). This way you may just regain some respect!

Source:

I would like to give credit to Damon Cali for using his well-thought-out diagrams: **http://bisonballistics.com/articles/the-science-of-cartridge-brass-annealing**