Practical Joining

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HISTORY AND OVERVIEW

It is impossible to identify the earliest cold connection—but fun to try. A romantic might think of that moment when our simian ancestors fastened a sharp rock onto a stick to make a spear. That must have come early in the history of joining, as did the mechanics of attaching skins together to make garments and shelters. We don't need to go that far back, except to make two points—joining techniques are old, and they have been invented by people like you and me.

Each discipline and material has generated its own catalog of joining methods. Carpenters approach problems differently than tailors; engineers think differently than artists, and this translates to a colossal wealth of resources for us. This book (or any book for that matter) cannot hope to be a complete summary of the ways parts can be joined. Apart from the impossible size of such a work, it would be instantly out of date. As I write this paragraph, some inventive person is developing a new approach. Rather than an encyclopedia, this book will try to be a map of the territory. Armed with this, you can have a deeper understanding of your options and recognize opportunities for hybrid innovations.

I will focus here on small-scale metalwork like jewelry, vessels, and housewares. The information has been divided into three sections: hot, cold, and adhesive connections. Each of these has a rich history in metals, and each could generate a fascinating archaeological survey in its own right. For the moment, we'll confine ourselves to a few snapshots. In dynastic Egypt, at a time when Europe and the Americas had almost no recognizable culture, goldsmiths were assembling complex and delicate ornaments. It is useful to remember that they started their work by purifying the gold they would use, then converting the crude ingots to useable sheet and wire. This process gave the ancient smiths an intimate understanding of how to control fire and melting points, the two cardinal ingredients in soldering. They also discovered that powdered malachite, a green mineral used by Egyptians for eye shadow, facilitated melting. Today we use the same chemistry in our fluxes. The pharaoh's goldsmiths, along with the Greek and Etruscan craftsmen who followed them, created work of incomparable beauty, all of it dependent on precise control of heat.

Fast forward to medieval Europe, to a time when monks and adventurers traveled to faraway lands in search of converts and treasures. They returned with a huge range of objects, including antique ceramics and eggs the size of melons. These curiosities were taken to silversmiths to have them mounted for use (a pattern that continues to this day). Imagine the challenge of fitting a silver base and rim onto a rare ostrich egg or a thousand-year-old Chinese vase. Heat could not be used, so the clever smiths devised cold connections to attach the parts.

We tend to think of adhesives as a modern invention, and this is a reasonable assumption because so many of the glues we use were developed in the last fifty years. But down the street from the Egyptian goldsmith, there was a furniture maker using casein glues to secure joints in wooden objects that still exist—and still hold together—today. The Renaissance goldsmith and author Benvenuto Cellini, described adhesives used in his day. In the nineteenth century, production firms such as Gorham Silver closely guarded their recipes for the adhesive pitch they used to fill knife handles and pedestal vases.

Against this backdrop of a long and fascinating history, contemporary metalsmiths learn from the past, take inspiration from the genius of their predecessors, and continue to invent new ways to join parts together.

Part One

Cold Connections

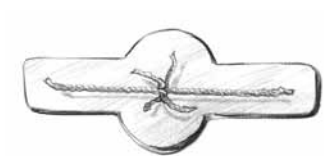
INTRODUCTION TO COLD CONNECTIONS

Cold connections, also called mechanical connections, are so basic that they often go unnoticed. When you pick up an apple and hold it in the palm of your hand, you've made a cold connection. Change the apple to a gemstone, and replace your fingers with small rods of metal, and you've got a prong setting. Cold connections are universal and inevitable. Like water or bees, life as we know it could not occur without cold connections.

Reasons to use Cold Connections

The most obvious reason to use cold connections is because you can. Why pick up the apple with your fingers? Because it's a lot easier than doing it with your elbows. In the world of metalsmithing, there are more serious answers, including:

joining heat sensitive materials

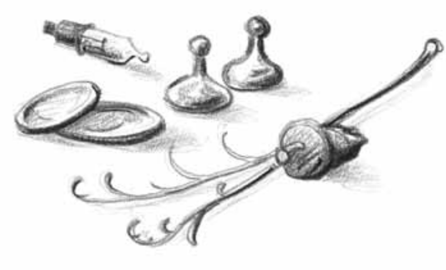


removability of parts

preservation of patina, temper, etc.

Heat Sensitive Materials

Far and away the most common reason to use cold connections is because hot connections are not an option. Try soldering a shell onto a copper panel and you'll quickly see the problem. Mastery of cold connections allows metalsmiths to use nonmetal objects in their work. This includes shells and twigs and stones. It includes plastics and leather and paper. And fabric, electronic parts, glass beads, toys, currency… you get the idea. The already rich palette of metals is magnified many times over by having access to this range of materials.

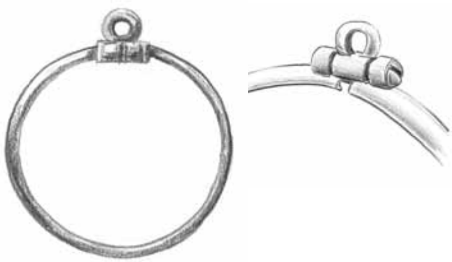


Preservation of Metal Attributes

There are times when materials could be connected by soldering, but there are reasons to avoid it. Imagine a bronze element with a delicate leafy green patina to which you want to attach a sterling finding. Bronze and sterling can be soldered together, but in this instance, it would destroy the patina. Cold connections to the rescue. Another example involves the best way to join a sterling fitting to a hardened and tempered knife blade. Again, the metal can be soldered, but in this example, the edge-holding ability of the steel will be diminished. This is another place for a cold connection.

Removability of Parts

Most cold connections are easily reversible. You can unclasp the apple and it will be unaffected. Some cold connections, like bolts for example, are especially good for this, so it is no surprise that they are used when we need a connection that can be taken apart. In other cases we might not anticipate that the connection needs to come apart, but we want to leave the option open. An example of this situation is a coin that is mounted to be worn as jewelry. The connection needs to be secure enough to insure that the coin is not lost, but the piece should be designed so it does not reduce the numismatic value of the coin. Soldering, drilling, or gluing a coin makes collectors go crazy.



Health and Safety

Another reason, more idiosyncratic I guess, but worth mentioning, is that cold connections avoid the use of fire and chemicals like fluxes and pickles. For a jewelry professional this sounds silly, but if you are working with children, or in a restricted environment, this is an excellent reason to head toward cold connections. And then there are people who just plain don't like torches. Sure, therapy is an option, but so are cold connections.

TENSION

Tabs

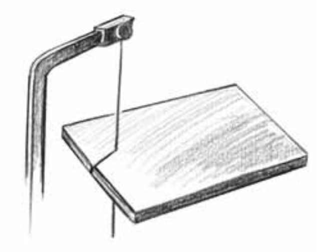
Tabs are extensions of one piece that wrap around another piece and lock the two together. A familiar example shows up in paper dolls, in which small fingers extend out from the smocks and hats used to dress the dolls. The same wonderfully simple option exists for jewelers, and presents many variations.

Process for Making Tabs

1 Trace one element onto paper.

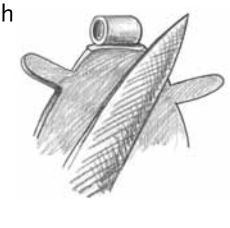
2 Think through the locations of tabs to insure that the parts cannot slide apart in any direction.

3 Transfer the design to metal and saw it out.

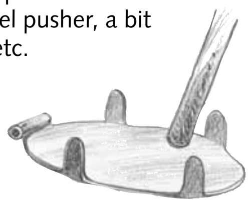


4 Anneal the metal if it is not already malleable.

5 File and sand the edges, solder parts such as bails or accents if they are needed, and create the intended finish



6 Bend the prongs to a vertical or "poised" position, insert the new piece, and press the tabs down with a bezel pusher, a bit of wood, etc.



ORNAMENTED

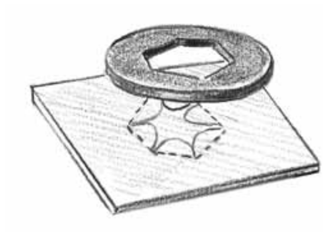
Maybe because of their association with paper dolls, we often think of tabs as small rectangles with a rounded end. Clearly there are more interesting shapes.

Internal Tabs

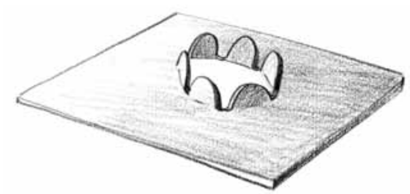
The idea is simple, and leads to a whole species of interesting possibilities.

1 Trace onto paper the interior opening of an element you want to join.

2 Sketch in tabs that will be made from the metal inside this line. Cut the paper pattern to test the effectiveness and appearance of the tabs.

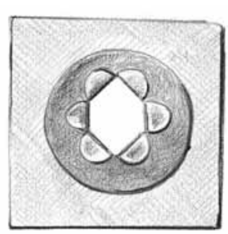


3 Transfer the pattern to metal. Drill access holes to allow for inserting a sawblade, and cut out the tabs.



4 As before: file, sand, solder (if needed), patina, finish.

5 Bend each tab to a vertical position with pliers. Insert the piece and press the tabs over with a non-marring tool like a wooden dowel or a plastic brush handle. If the piece won't be damaged by impact, you can tap the tabs with a rawhide or plastic mallet.



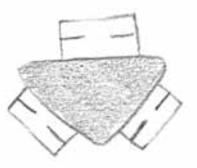
Note: Several cold connected pieces can be layered together for an interesting effect. For instance, two pieces joined with interior tabs could then be set using outside tabs, rivets, or other joining techniques,

Lateral Tabs

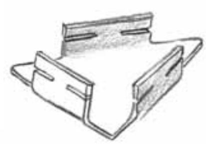
These tabs are similar to the conventional "bent finger" idea described earlier, but in this case, the tabs are not bent over the object. Instead, metal fins are bent so that their bottom edges trap the pieces to be held.

1 As before, start by tracing the object that you want to hold.

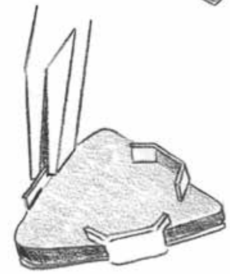
2 Figure out where the tabs will be. In many cases, as in this example, the tab will first bend up vertically to make a wall that will hold the piece from sliding side to side. Layout the lateral tabs, typically by making a single saw cut (A). It is a good idea to test the idea on stiff paper.



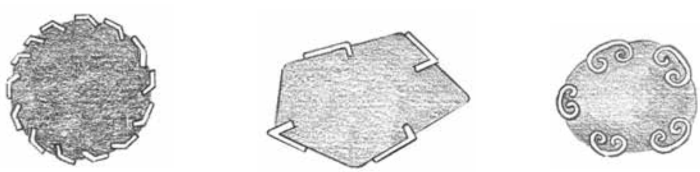
3 Cut the metal to the proper shape, solder on additional parts (if necessary), and finish with patina, polish, etc. Bend the tabs upward, here to a 90° angle.



4 Set the object in place and bend the tabs sideways to lock the piece in position.



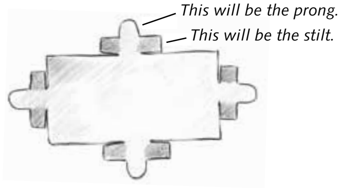
Variations: Lateral tabs can be quite minimal, very complicated, or almost anything in between.



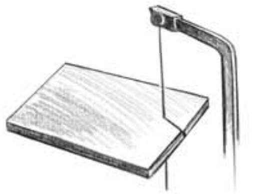
Stilt Tabs

Here's a variation that can add drama and interest to a design by creating a space between layers, The shadow box effect is elegant, and the arrangement has the added benefit of accommodating a projecting element on the underside of a piece. Imagine, for example, that you want to set an antique button without cutting off the eyelet on the back side.

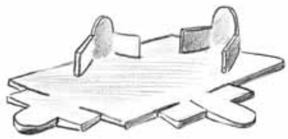
1 Start as before by tracing the piece to be set and determining the location of the tabs. Add "wings" to each tab equal to the height you want the piece to hover above the base. Bear in mind that a small space is often enough to make a powerful visual statement.



2 Transfer the pattern to the metal, making sure to note the areas where saw cuts will allow the metal to be bent. Saw, file, sand, solder, patina, and finish as needed.



3 Use pliers to bend the wings upward. They might come all the way to a right angle, but this isn't necessary.



4 Pull the tabs upward. The bottom edge of the wings will be resting on the base sheet.

5 Set the element as before, by pressing the tabs down onto it.

Positioning the Tabs

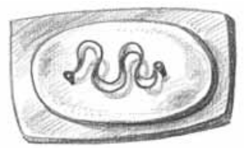
Often the location of the tabs is symmetrical, but that's not a requirement, as long as the piece is protected from sliding out in any direction.

STAPLES

Is there anyone who isn't familiar with staples? They are thin pieces of steel wire bent into a broad "U," and lightly glued into a long trench that fits neatly into a tool that lives in the desk drawer. Well, yes and no. That's certainly what staples mean to most of us, but it's not the only form they can take. For our purposes, forget about the very specific device used to join sheets of paper together and think about how a staple works. Two or more pins go through a layer, or several layers, and are bent over to prevent their coming out. That definition offers a lot of room for design innovation.

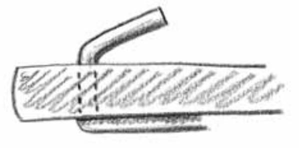
Basic Staple

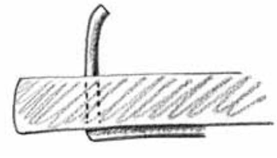
The most obvious things a metalsmith can do is to enlarge the staple, change the metal, and make the bar that connects the pins more interesting. For example, imagine bending a serpentine design in a sterling silver wire. To make the line more interesting, you could planish it on the apex of the curves. This changes the visual weight of the wire, making it swell as it rounds the loops. Bend the last quarter-inch of each end down and you have a staple, but one that is a lot more evolved than what you can buy at an office supply store.



- The legs can be bent toward each other or away, whichever shape works best for the design.

- If there is a trick to this cold connection, it is to insure that the tips of the pins lay flat against the back of the piece. Note that tapping slightly raised legs usually makes the situation worse, not better. Instead, start by curling the tips slightly (only slightly) in the direction that will be against the base when they are set. Bend them by working close to the place where the pin comes through the holes in the piece.



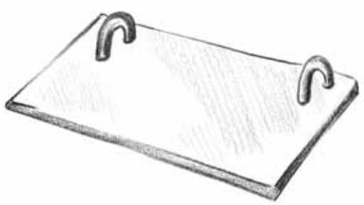


Blind Staple

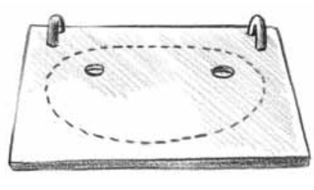
This slightly more complicated version uses the same idea as a paper fastener, the brass disk with two thin legs that we all used in grade school. In our case, we'll solder wires onto the underside of an ornamental element. After polishing, the piece is attached the same way—drill holes in the parts to be joined, insert the legs, and bend. The pins can be close together (like the paper fastener) or separated, like a staple.

1 Make the ornamental piece, which I'll call the "cap." This can be sawn, cast, made in metal clay, or fabricated in dozens of ways. It could also be a bezel that will later hold a stone.

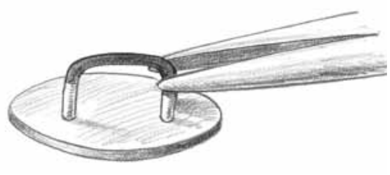
2 If there is work to be done on the base piece (there usually is), do this first. This would include things like soldering on pin findings, bails, or other attachments. The idea is to get these parts properly located first. Drill holes in the base piece where they will not be in the way of other parts of the piece, such as the pin finding.



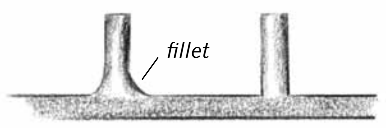
3 Hold the cap against the base and scribe the location of the holes. If you use a pen, follow this by scratching marks with a needle or scribe so the location will show up during soldering, after the ink has burned away.



4 Solder lengths of wire precisely onto these marks. A neat way to hit the marks and simultaneously make the soldering simple, is to bend a length of wire into a large U-shape. Adjust the gap between the legs until it fits the marks. Fuse solder onto the tip of each leg, then hold the inverted "U" in position as you heat the cap with a torch. Some people like to use a weighted base with locking tweezers called a Third Hand to assist in this operation. After soldering, cut off the connecting portion (shaded).



5 Check the soldered joint to be sure it is solid. If there is a fillet at the base of the pin, file it away so the staple will rest securely against the base.



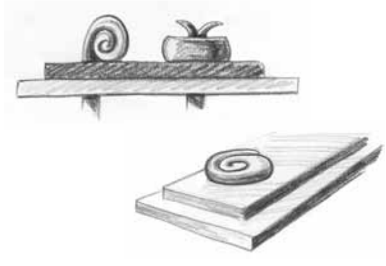
6 Finish all parts (patina, polish, etc.), then slide the parts together and bend the legs, first with a pliers, then by pressing each one down with a wooden dowel or plastic rod.

Multiple Legs

This variation is almost identical to the one above except that it uses more than two pins. The piece is more secure, especially if the cap has multiple extensions. The method is the same: solder U-shaped brackets of varying height to connect two pins with each solder operation. Cut only after all soldering has been done and checked.

Curled Ends

Instead of simply pressing the pins down, some designs will be enhanced by giving the pins an interesting shape. They can be wound into a spiral, for instance, and left standing at a right angle to the piece, or folded down flat. These can be on the back of the piece, but maybe they offer an embellishment that deserves to be on the front. The pins can be adorned with beads before being bent over.



Cotter Pins

This elemental version of a staple is familiar to machinists, but doesn't often find its way into jewelry. It is simplicity itself—a hybrid between a staple and a paper fastener. For the people who manufacture them, the beauty of the idea is that the loop in the wire is all that is needed to keep the pin from pushing through from the front.

For jewelers, this loop makes a great place to attach dangles, hang beads, or connect to a necklace cord. The loop can be hammered, textured, or simply left alone.

BEZELS

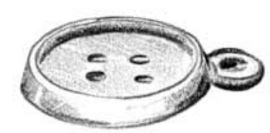
A bezel is a rim of metal that surrounds a gemstone and is pressed down over its curving edges to clasp the stone to a metal object. In most jewelry books, bezels show up in the stonesetting section (as they should), so they can be overlooked as a breed of cold connection. They shouldn't be.

Variations on bezels are so numerous that it is impractical to attempt to cover them all here. Readers are directed to books on stonesetting, where dozens of variations will be explained. On the following pages, I'll describe a couple basic approaches to illustrate the way bezels can be used on materials other than gems.

Basic Bezel

The parameters are general, but important.

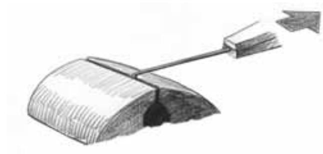
- A bezel must make a neat and snug fit around the object being set.
- It must be securely attached all the way around the base.
- It should not extend over the piece more than is necessary. This will be determined by the angle of the piece—the straighter the sides, the more bezel is needed to achieve a secure grip.



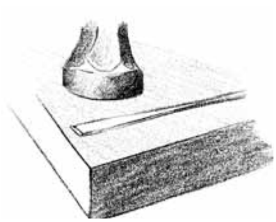
Bezel-set button

Making a Simple Bezel from Copper Wire

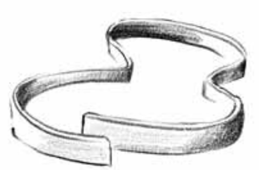
1 Straighten a piece of wire by gripping one end in a vise with the other in pliers and pulling it taut.



2 Planish the wire with a polished hammer. If the wire curves, it is because the hammer blows are not landing squarely. Adjust as needed. Snip and file one end of the wire to make a square end.



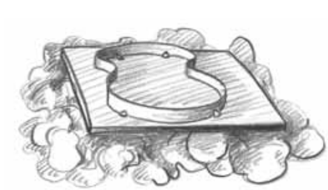
3 Bend the loop to fit the object, either by eye or by bending it around the piece itself. The wire will always spring back, so go past the joint to allow for this. Check against the object periodically as you work to make a perfect fit. Fussiness at this point will make a better looking bezel and an easier setting job later.



4 When the fit is assured, snip the end and solder the loop closed. Use only a tiny piece of solder—first, because we don't want a silver blob on the copper bezel, and second, because solder is stiffer than copper and a bulge of solder will be difficult to press down during setting.

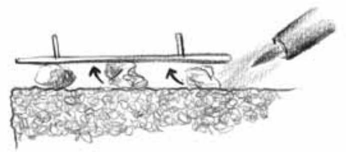
5 Check the fit by pressing the bezel onto the object. In the process, be careful that you don't distort the wall. It must remain vertical. Rub the bezel on sandpaper so the bottom edge is flat.

6 Clean a piece of metal that will be the base, and apply a layer of flux. Lay this on a bed of pumice pebbles rather than setting it flat onto a soldering block. This will allow heat to surround the sheet and let it heat up faster. Set the bezel into position and slide it back and forth to transfer a film of flux onto the walls of the bezel.

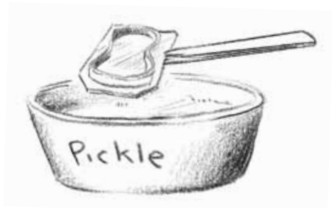


7 Set small pieces of solder against the bezel so they are in contact with both the wall and the base. If you plan to cut away the metal around the bezel, put the solder on the outside of the loop. If not, put the pieces on the inside.

8 It is best to have the solder flow all the way around the base of the bezel in one flash. To accomplish this, direct the torch flame entirely at the sheet, angling the flame so you shoot it under the sheet. Allow the heat to travel from the underside of the sheet upward to the bezel.



9 When the solder flows, immediately pull the flame away. Allow the piece to cool for a few seconds, then quench it in water. Examine the joint, and if it is complete, put the piece in pickle to remove flux residue and oxides.



SETTING WORK IN A BEZEL

Bezels used in this context are no different from when they are used to hold stones, so this information will duplicate what is available elsewhere in stonesetting descriptions. It is included here as a convenience.

Determining the Height of a Bezel

Metal has an ability to compress, which is what allows it to be hammered into teapots and corrugated into relief. When a bezel is pushed over, we make use of this ability. To understand how important this is, compare it with a material that does not have this ability, such as the paper this page is printed on. If you hold up a piece of paper and press against it, it will bend in the direction you press, and flare out in other directions to compensate. Press those flared areas in, and the paper will flare out somewhere else. The material needs to occupy a given amount of space, period. What makes a bezel possible is that the metal in the vertical wall can be squeezed together enough that the wall can be angled in against the object being set. But there is a catch. Metal has a limit to how much it can compress without being annealed. Annealing, a process that involves high heat, is out of the question once the element is in place, so we must work within the limitations of the metal.

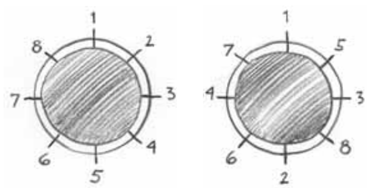
Fortunately, this is easy to do. The best way to avoid a problem is to limit the height of the bezel. The taller it is, the more compression will be needed at the upper rim of the bezel. This can make the setting difficult and the edge irregular and lumpy. More than that, the reason the bezel is there is to display the thing you are setting. It only makes sense to show off as much of it as possible.

To determine the proper height, do not push the piece into the bezel. Read that again: Do not push the piece into the bezel. It's likely to get stuck there, and a lot of foul language and fussing will be required to get it out. Instead, set the piece beside the bezel, and gauge the proper height by eye. Make a mark with a scribe or pen, then trim the excess away with a file or manicure scissors. Follow this with sandpaper; before setting, the top edge should be uniform and smooth.

Setting the Bezel

When the height is correct, all soldering has been completed, and the finish is complete, press the object into the bezel. It's not uncommon that normal handling has caused the bezel to lean inward. Use a blunt tool to gently pull the wall outward to its proper vertical position.

The compression described above needs to be distributed evenly throughout the bezel. The way to NOT do this is to start at one point and press the bezel down as you go around the form. Rather than compressing, this will simply push the metal ahead of itself and create a bulge when you get back to where you started. Instead, press the bezel down in one place, then go across the form and press from there. Move to a spot midway between those two and press, then go across from that and press again. You can think of this as being the four points of a compass.



NO **YES**

At this point the object should be gripped in place, though the bezel looks rather unattractive. Continue the process, starting midway between two cinches, and again jumping across the form for the next push. As the process continues, the waves of the bezel get progressively smaller until they are completely smoothed away.

A Little is a Lot

You'd be surprised how little metal is needed to secure an element in a bezel. Remember that this overlap is happening all the way around the piece.

Good

Too high