BOREWELDING AND WIRE FLIP

The term "wire flip" is used to describe a condition that happens in borewelding when the wire exiting the contact tip at the weld does not rotate evenly within the contact tip in the nozzle as the torch progresses around the bore. Instead, for most of the revolution the wire does not rotate in the contact tip at all; but, then it suddenly makes a full revolution all at once. If the wire is curved (has a "cast") this can produce an unevenness, perhaps even a void, in the weld deposit because the "flipping" wire causes a change in placement of the weld bead.

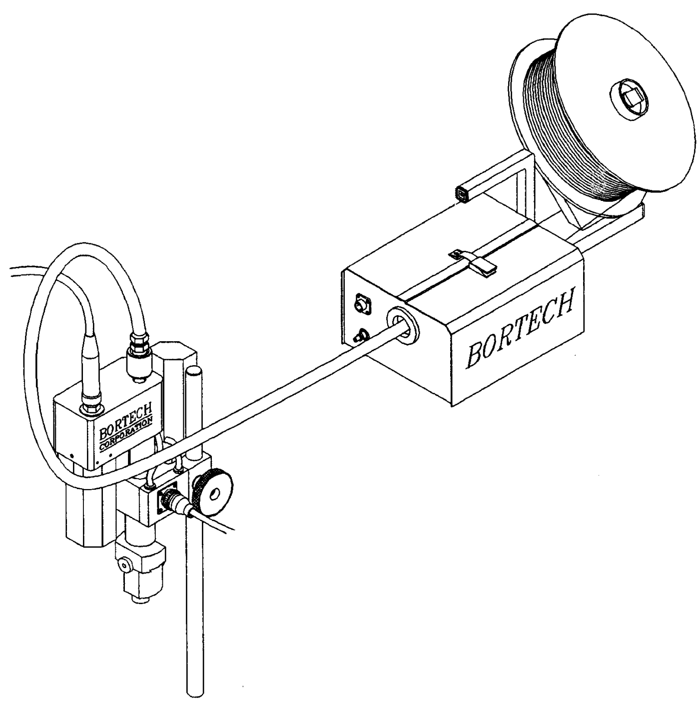
If totally straight wire is fed into the borewelding system, the "wire flip" will not occur even if the wire is bent into a curve upon exiting the torch. When using the smaller torches, straight wire entering the system will be curved after passing through the bend near the contact tip. This curve caused by the small torches will not cause "flip" but will definitely exacerbate the effects of "flip" if present as caused by a tight wire cast.

If wire flip is a problem, you might try the following to try to eliminate it:

1. Try to avoid an "S" shape in the conduit.
2. Position the Wire Conduit in such a way that the conduit makes only one continuous curve. That is, the conduit should begin curving at its attachment point on the top of the BoreWelder and continue this curve for about 270° (¾ of a turn) and then straighten out as it heads toward the wire feeder.

This method works well with long conduits. If the wire has a tight cast and it still flips even in this configuration, you might try "tightening up" the curve somewhat. However, as more torch extensions are added, this method becomes less and less effective.

FIGURE 31: AVOIDING WIRE FLIP



The remainder of this section describes why the flip happens and explains how to avoid it.

First, it is important to understand the term "cast." When wire is wound tightly on a spool, it may permanently take on some of the curve of the spool's hub. If a short length of such a curved wire is cut from the spool and thrown on a smooth floor, it will bounce and relax into its natural circle. The measurement of the diameter of this circle is the cast of the wire. Wire specifications usually list a minimum of 16" cast. Most wires tend to be from 20" to 30" and can be anything up to straight. For the BoreWelder, 20" to 30" is not enough. Use wires with a cast of at least 40".[4]

To understand wire flip, it is necessary to realize that while welding a bore, the BoreWelder's spindle and attached accessories (torches, etc.) rotate but the welding wire does not. The welding wire is prevented from rotating because it is pinched between the wire feeder drive rolls. So the BoreWelder rotates around a non-rotating welding wire. This means there is *relative* rotation between the welding wire and the contact tip. Under ideal circumstances (without wire flip occurring), while the BoreWelder slowly rotates, the welding wire appears to turn slowly and evenly within the contact tip.

Furthermore, the wire must travel through a curved path within a rotating member because the wire is at first central to the axis of rotation of the BoreWelder's spindle and somehow must be directed to the weld puddle which is not central to the spindle. This rotating member usually is the torch. Because the torch is rotating and carrying the wire with it, there is a slight torsional moment placed on the wire (if the torch was straight, only a very small moment would be placed on the wire). As described further in this section, it is the curve in the torch that increases the moment.

So now there is a torsional moment on the segment of welding wire between the wire feeder rolls and the torch curve. Remember that only the pinching of the wire feeder drive rolls is preventing the wire from rotating. But, the wire feeder usually is quite a distance (perhaps 7 feet) from the source of the torsional moment (the torch). This length of wire in the system is capable of storing a great amount of torsional stress created by the moment. Thus, as the spindle rotates, the wire begins to twist in the system. Eventually, as the BoreWelder rotates, the wire will store up enough of the torsion so the wire will begin to rotate in the contact tip. At this point, the torsional moment will stop building and stabilize. If the wire was not straight upon entering the system, the rotational movement at this point would be smooth and even although naturally there would be a slight lag between the time the BoreWelder first started up and the time the wire in the tip began its rotation.

With these concepts explained, we can explore an important property of curved wire. If a wire with relatively small cast (more tightly curved) is allowed to lie in its natural position and is held loosely in this position, there will be a resistance to rotation when you try

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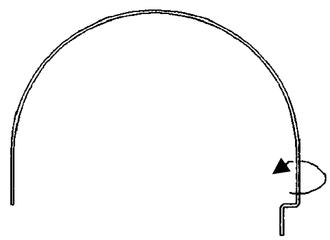
4. Cast can be beneficial to the electrical transfer at the contact tip. If the wire has a natural curve to it and is forced through a straight contact tip, it will become its own spring that forces electrical brush type contact on the sides of the contact tip's bore. However, this also could contribute to the wire seizing in the tip because of excess pressure causing galling of the wire to the copper tip.

to rotate one end of the wire. This is because the wire is being forced out of its “natural lay” position. The more you to rotate the wire, the closer it comes to being curved exactly opposite its natural lay position. Try it with a short section of wire. Bend a small crank in one end of the wire so that you may apply the torsion. In order to accentuate the effect, curve the wire more than its natural position. Then try to rotate the crank one-half turn and feel the resistance to your rotation. If the rotation force is increased, the wire will suddenly snap over the center of the exact opposite of it natural lay and around to its original natural lay position. It is important to realize that the resistance and then the “snap” is due to the wire being forced out of its natural lay position and then being allowed to rotate fully to return again to this natural position.

FIGURE 32: NATURAL LAY POSITION



What happens to this wire with a small cast when a BoreWelder’s contact tip carries it around a bore? (In the following discussion, we will neglect any effect the axial travel of the wire might have on the system because, with regard to wire flip, the effects of this travel are minimal.) As the BoreWelder begins to rotate, torsional stress starts building up in the welding wire. A long distance between the torch and the wire feed rolls will allow considerable rotational movement to be stored in the wire—perhaps as much as one turn or more. Within the BoreWelder’s spindle and torch extensions, the path of the wire travel is straight[5] so no uneven wire rotation should be initiated here. But in the torch, the wire must be directed toward the wall of the bore. The wire must, therefore, travel through a curve that is continually rotating about the axis of the bore.

A wire with cast in this curve has a preference as to how it is positioned. It wants the plane of its own natural curve to match up with that of the curve within the torch. So, as the torch rotates, the wire between the torch and the feed rolls begins to absorb a torsional moment while the wire’s natural curve remains in the plane in of the torch’s curve. This will continue until a sufficient torsional moment has been absorbed for the rotational force to overcome the wire’s predilection to having its curve plane match that of the torch. The wire then will make a sudden, nearly complete, revolution in the tube of the torch until its curve again lies nearly in the same plane as that of the torch. This revolution will be carried to the contact tip and this produces the wire flip. This cycle repeats as long as the torch rotates. If the cast of the wire is large enough, its desire to match the plane of its curve to that of the torch no longer is an issue and the wire rotates evenly within the torch tube.

5. Within the Offset Head, the wire is likely to jog through two curves in order to obtain the offset. However these curves are in very close proximity to one another. Thus, any degree of rotational position the wire may be in is immediately and equally compensated for in the second curve. This cancels any “flipping” tendencies that might otherwise be present.

Shortening the conduit length will help eliminate the wire flip since it lessons the length of wire to the feed rolls and thus the torsion storing capacity of the wire. However, this is not always possible. But, there is another way to make the conduit seem shorter. This is to form a rather tight curve in the conduit just as it enters the top of the BoreWelder. This takes advantage of the wire's desire to match the plane of its curve with that of the conduit. The conduit torsionally "grips" the wire at a place much closer to the torch than the feed rolls. The conduit seems shorter—it acts like the wire feeder drive rolls are in the conduit close to the BoreWelder.

If possible, the best solution is to obtain welding wire with a cast large enough so wire flipping does not occur. This depends on the specific configuration the particular job dictates. However, a cast less than 32" will most always produce flipping problems. Casts above 40" are recommended because flipping is rarely, if ever, experienced.

NOTE: If the wire feeder is moved 180° with respect to the BoreWelder's spindle, it is likely that the unevenness in the weld deposit caused by the flip will be moved as well—possibly the same 180°. This is due to the wire's predilection to match the plane of the wire feeder conduit's curve. The wire rotates to its most comfortable position within the conduit which is now 180° from what it was previously. This moves the flip in the bore of the workpiece.