Title	TDS No.	Date	Revision
Basic use of Laminated Central Conductors	15	05/20/02	A

In certain applications using laminated central conductors have several advantages over the conventional copper central conductor. We will cover several such applications and explain why use of these can be advantageous.
Basic understanding of the MPI process is assumed.

Application #1

Consider a ring shaped test specimen such as a bearing race, precision spacer, ring gear and the like. In most cases it is either required or advantageous to test this part in all directions for cracks, which may be from inherent material defects or having occurred during manufacturing, heat-treating, grinding or other secondary operations. This testing process is also generally required to have no potential for arc burns; which means all magnetizing operations have to be of the *indirect* induction type, such as one might expect in using a conventional air-core coil or equivalent design.

This would require that the part be processed using several steps to magnetically cover it in all directions. Generally a central conductor shot on a copper bar would first be used, then the part would be placed flat in bottom of the coil for step 2, then rotated 90 degrees in the coil for step three to cover both quadrants of the part. In some cases the coil shots may have to be repeated a second time after flipping the part over so inspection of the backside may be accomplished. This would then require a *minimum* of 2 setups and 3 processes per part for adequate inspection.

In many cases, inspection of this type of part may be reduced to one shot with a 2-vector machine using the laminated central conductor. Use of this type of combination will effectively induce fields in both directions without fear of arc burning the part. Additionally the traditional l/d restrictions for coil shots can be ignored.

Fill factor considerations will be much the same as using a conventional central conductor. For thin cross-sectional work pieces such as bearing races, one may closely estimate the *conservative effective* inspection area by first calculating the circumference of the central conductor and then dividing that figure by 2. For convenience purposes the effective inspection length is then measured around the OD of test part starting from the top tangency point using ½ the central conductor circumference each way. Fig 1 will illustrate this.

If the fill factor is not sufficient to cover the part in one shot it will be necessary in most cases, to either use a larger central conductor or rotate the part around the central conductor and re-magnetize it as necessary. The effective distance and field balance may also be double checked by demagnetizing the master part and rotating the QQI from the 12:00 position to the new position (3:00, 4:00 ect.) and reprocessing it. Observe the QQI for field balance and intensity changes. Demagnetizing between steps is strongly recommended.

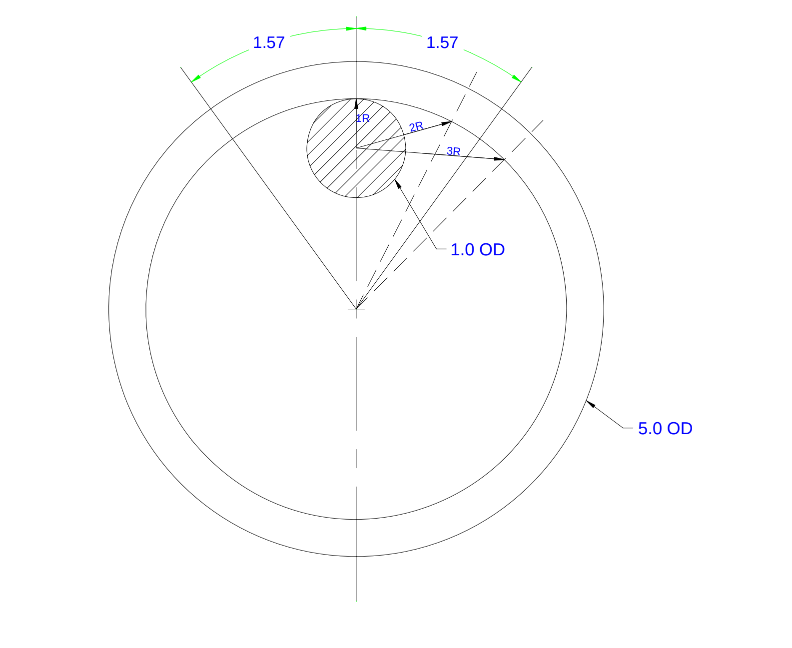


Fig.1 Effective Areas of Coverage with a Poor Fill Factor

Note: In the example to the left the central conductor is 1” in diameter making the circumference 3.14” and the effective inspection length each side of the centerline 1.57”

Technically to give closer results, the effective distance should be measured on the part ID based on a function of the bar radius but for thin cross-sectional work the OD may be used. Both methods are show here for comparison purposes.

Using a 1” bar with a 5” OD part would require rotating the part approximately 4-5 times while a 2” bar would require rotating the part 2-3 times.

When using a square central conductor the circumscribed circular diameter is generally used.

The next two diagrams show the same part with larger central conductors and how the difference between the two different calculations increases as the fill factor is increased. Remember that these examples are of thin cross-sectional work pieces and are not applicable to thick cross-sectional work. **Application #2** is an example of a thick cross-sectional work piece with a good fill factor.

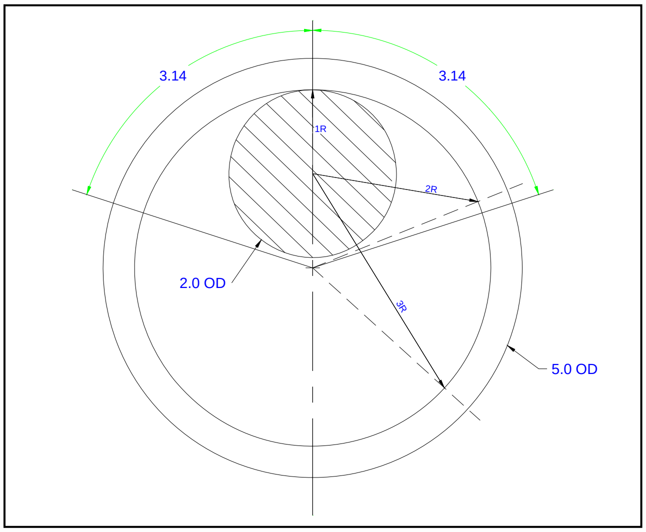


Fig. 2 Shows the same part with a 2" bar

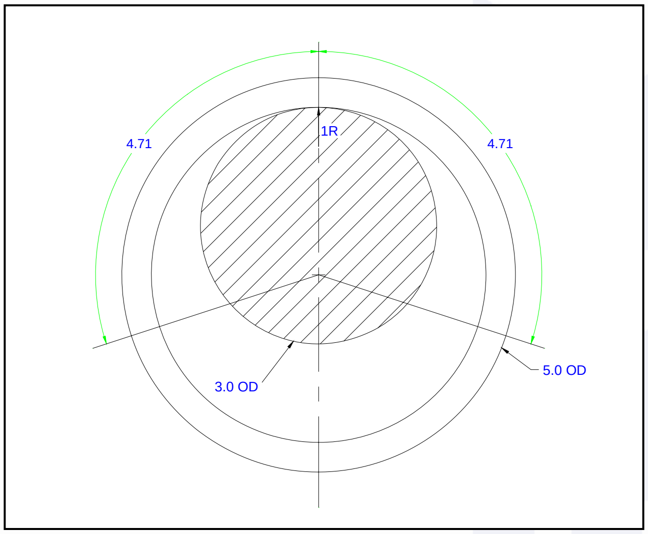
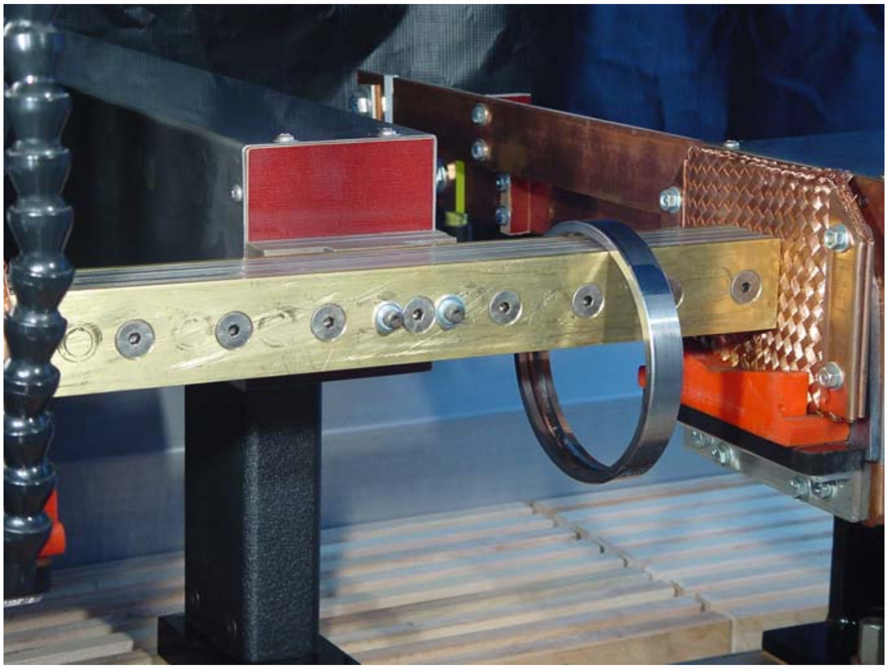


Fig. 3 In this example 2R covers the entire part

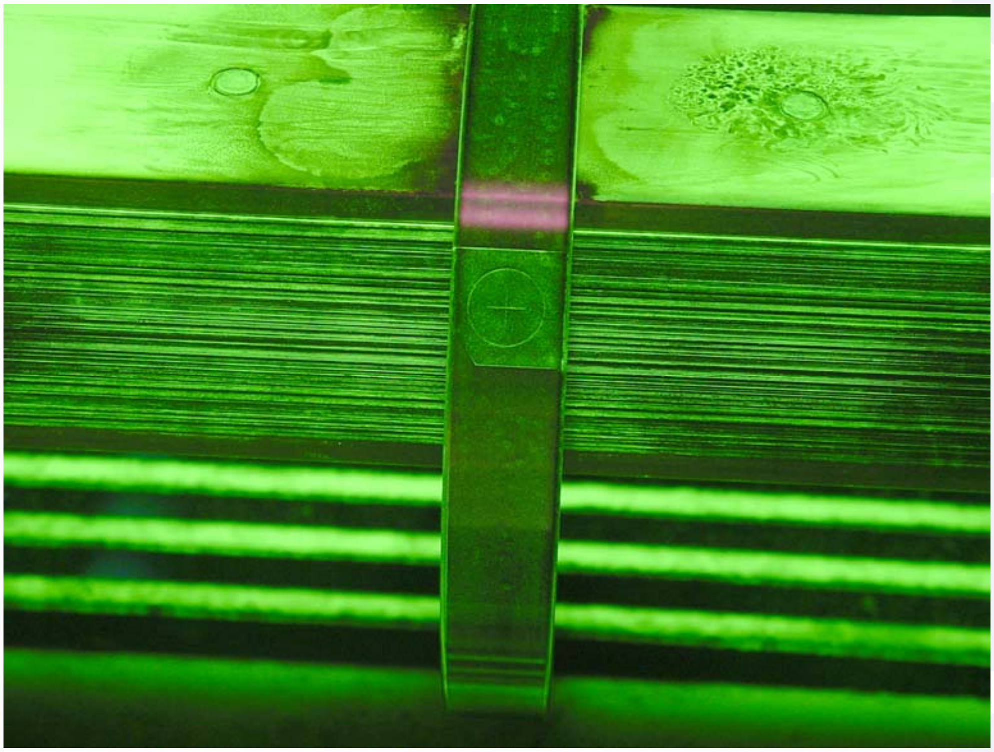
The lower photograph shows a typical installation of a laminated central conductor on a multi-directional machine. In this photograph the central conductor is mounted to a semi-automated fixture for material handling. This allows the operator to have both hands free and as the bar grows in both size and weight he does not have to hold it; handy although not necessary.

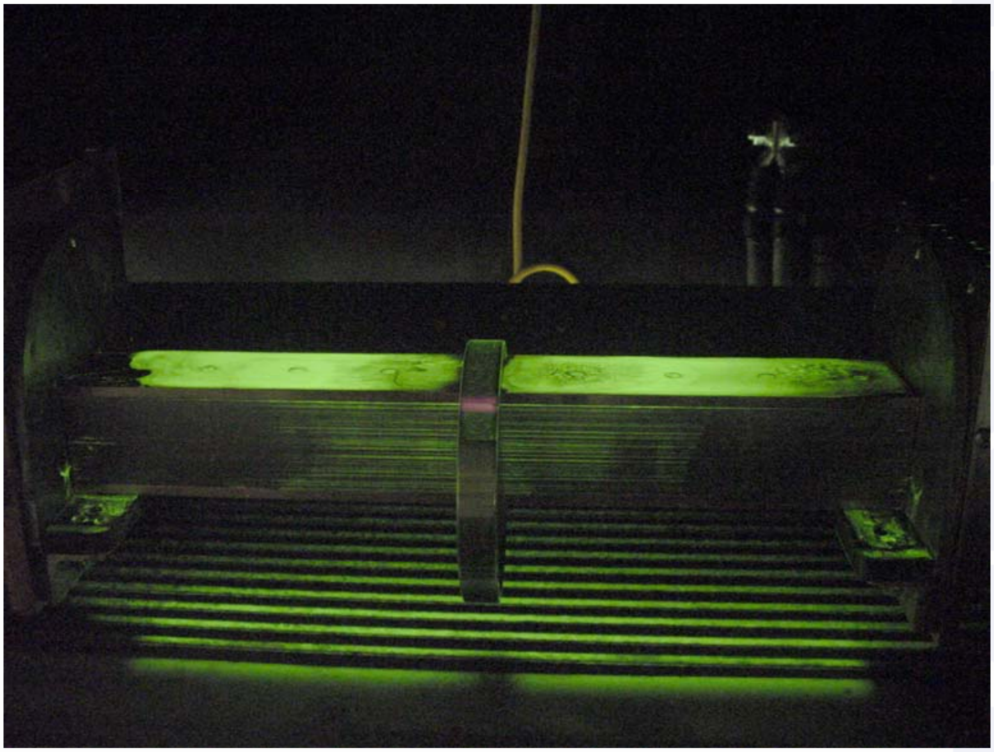
As a note, use of the double copper braided pads shown here are generally not necessary if the bar can be oriented squarely between the head and tailstock. Magnetizing efficiency will be increased without the use of these pads due to the decreased air gap between the bar and the electromagnets. If pads were used during the part procedure development with QQIs it is important to either continuing using these pads or adjust the currents as necessary to compensate for the extra air gap and give a balanced field.

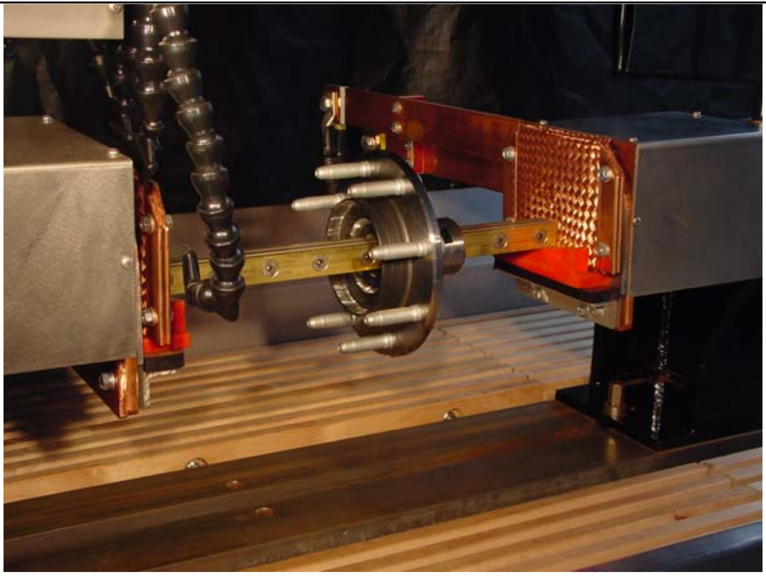


Actual QQI indications can be seen on the following page using a similar setup.

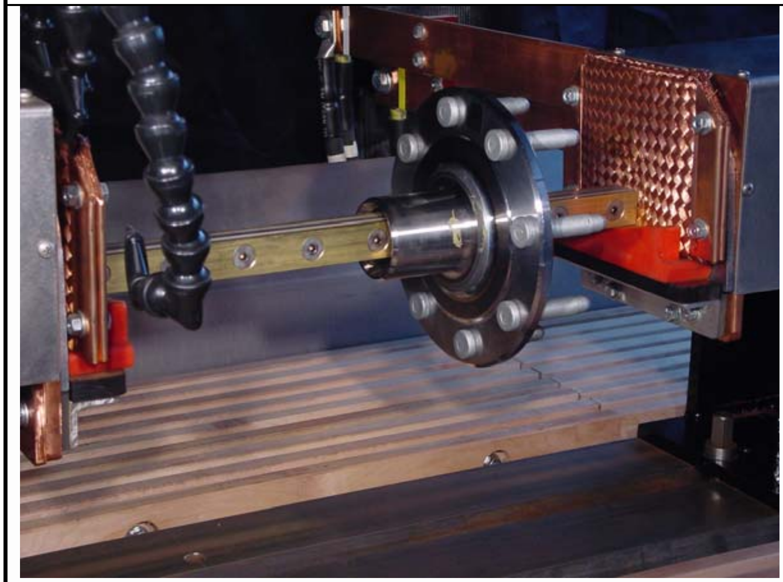
This example is of a 5-¾ " diameter, bearing race installed on a 2-½ " square laminated central conductor.
The machine is a Magwerks model MVS-2445 and the QQI was developed using an AC waveform for surface indications and the amperages used were 1500 amps on the coils and 500 on the contacts.
The coils were wired in series and phased to develop a standard unidirectional cumulative field.
As can be seen from the QQI the fields were in balance and the fill factor was sufficient in this example to allow testing of the entire race with one shot.

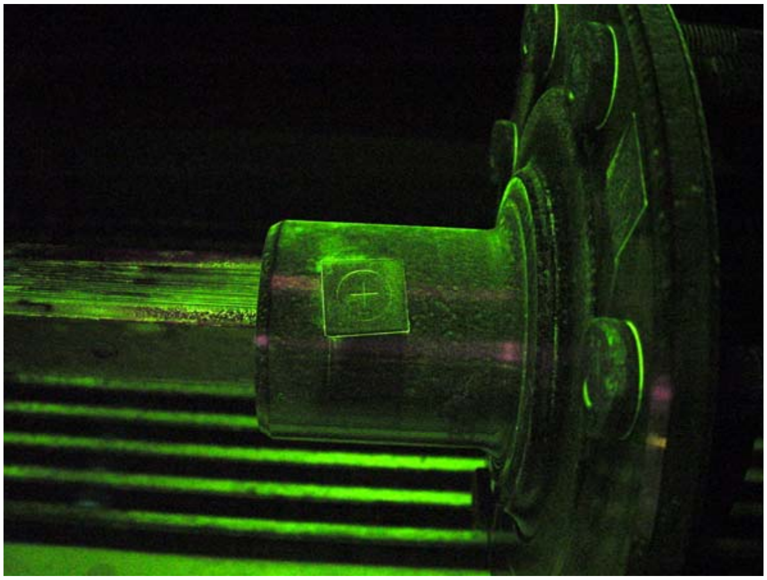






This photo shows the same part placed in a Magwerks model MV-2446 wet horizontal MPI machine using a 1-½ ” laminated central conductor 18” long.





Close-up showing balanced fields on the QQI.

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