Digital Readouts on the Smaller Lathe

David Haythornthwaite looks at the problems encountered when fitting a Digital Readout on the smaller sizes of workshop lathe and describes his particular solution to these difficulties.

Overview

A Digital Readout (DRO) is a tremendous asset in increasing productivity on a lathe. Having seen many attempts at fitting digital readouts to model engineers lathes, I noticed that most solutions caused inconvenience and loss of functionality of the lathe. I set about trying to equip my lathe with a DRO, maintaining all existing functions, whilst still looking to be very much an integral part of the lathe.

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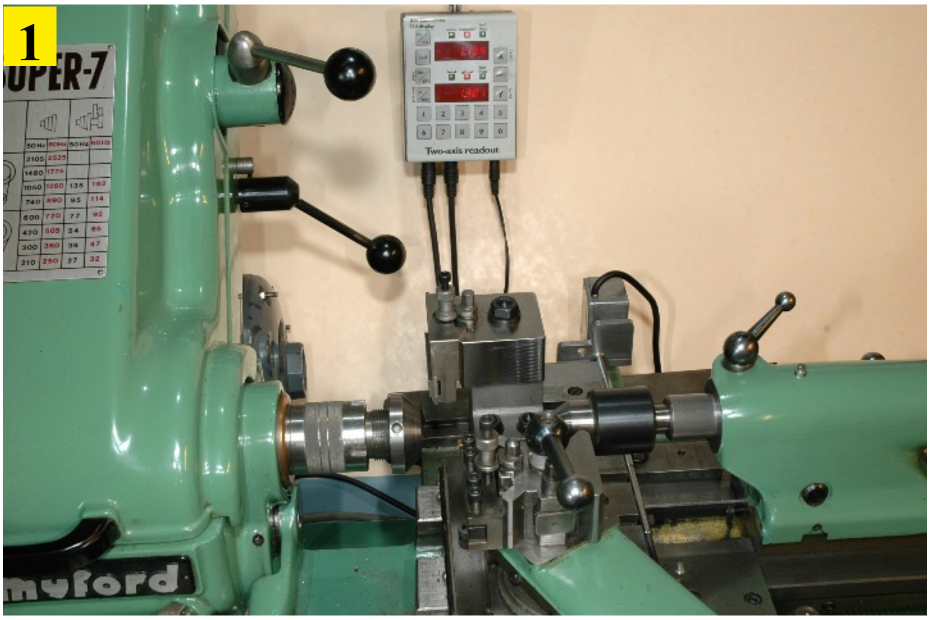


A Digital Readout Fitted to a Myford Super 7

Like many modellers, I have limited budgets to spend on my hobby, and I longed to have DROs on both my milling machine and my lathe. The cost of two DROs seemed to be rather damaging to my purse. Whilst fitting a DRO to my milling machine (A Wabeco 1210) seemed to be fairly easy, the lathe, - a Myford Super Seven – proved to be more complicated due to lack of room. Whilst this article lists my experiences at trying to obtain an economical and practical solution on a Myford lathe, the examination of the difficulties involved and the things that need to be considered, are equally applicable to other smaller lathes and to many other types of DRO.

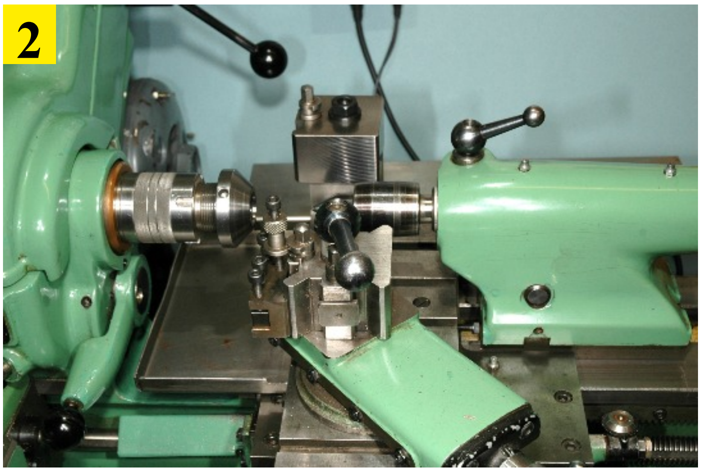
Early Consideration of Different Types of DRO

Around six years ago, I looked at several different ways of obtaining digital position indication on my lathe before making a decision as to the way I would follow in this quest. The first, obvious, choice to look at was the type of scales used on industrial machines. Most of these were too large for the smaller lathe, but the Newall system seemed to be compact and robust. However at around £1,200 in those days, the cost was way beyond my budget, although I still do like the Newall system and indeed I think it is now fitted by Myford to their Connoisseur lathe.

The Chinese glass scales later came onto the market at a much more affordable price, but they are much bulkier than the Newall system and I still find them to be fairly impractical on a small lathe, although offering a good solution on many milling machines.

I considered using a digital calliper clamped to the cross slide for the x direction only, and indeed one or two MEW contributors have done this with some success. However this is very much a “make do and mend” solution in my opinion. It does not easily cover the full saddle travel in the “Y” direction, looks poor on the lathe, and gives you none of the useful features usually included with a good DRO system such as local and global readings etc. It is however very cheap.

I seriously considered the magnetic scales that were coming onto the market at the time, but could not get these scales to fulfil my requirements which were as shown below.



There is very limited room for a DRO

The BW334 Display With One Sensor

My Requirements for a DRO on my Lathe

1. I use a taper turning attachment on my lathe, which, due to the lack of access to the back of my lathe, is permanently attached and is protected from swarf etc. by a stainless steel cover when not in use. Most types of DRO make the fitting of a taper turning attachment (TTA) extremely difficult or even impossible on the smaller lathe due to the fact that the "Y" scale and / or the read head are too large to fit beneath the cross slide when it extends over the back of the lathe, and at the same time clearing the taper turning attachment. I have seen "Y" scales fitted at the front of the lathe bed, but in my opinion they spoil the look of the lathe and are usually still in the way of many operations.

2. I did not wish the scale to be at the headstock side of the cross slide as it would be vulnerable to damage when turning large diameter items. It would also be vulnerable to swarf and coolant. Additionally, on the Myford the fixing for the travelling steady would be covered. I also frequently use this fixing point to attach a travelling swarf collection tray to the saddle as shown in **Photo. 2**.

3. I wanted to retain easy access to all "T" slots on the cross slide from both sides, and wished to retain the rear tool post which is almost always on my lathe. The rear "T" slot is also used for attaching to the TTA when turning tapers.

4. The Myford saddle is recessed at the tailstock side to allow the tailstock to slide between the bed "ways" and allow the tailstock to be fixed as near as possible to the headstock without unnecessary restriction of the available movement of the saddle - see **Photo.2**. Most small lathes follow this pattern, and when fitting glass slides to the tailstock side of the cross slide, then the tailstock has to be moved back from the cross slide to allow room for the slide. This leads to large overhangs of the tailstock.
Of course it is possible to fit a glass slide to the cross slide (just) so that the entire measuring system, including reading head, is either at the front or the rear of the lathe, but the overhang of the DRO is very inconvenient.

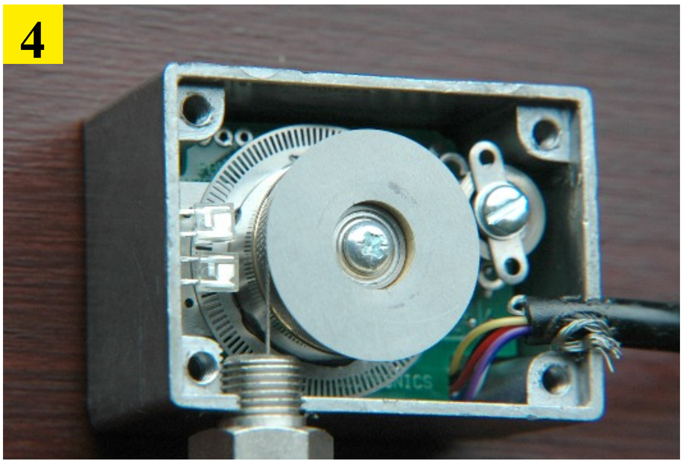
5. I wished to retain access to the gib strip adjustment screws on the cross slide, which are situated down the tailstock side of the cross slide. The access to the saddle clamp was also important, although this could be overcome if necessary.

6. Finally, I did not wish to drill holes in my lathe. This ideal did not prove possible, although I managed to keep any surgery on my lathe to a very minimum. I also wanted any solution to look and feel right on my lathe.

7. I eventually decided on a solution to these problems using an unusual DRO system. It works extremely well for me, but if the reader of this article decides on a more conventional solution, the problems of space are the same and the above comments may provide food for thought before embarking on the purchase of a system. Equally, my system was being fitted to a Myford lathe, but most of the Chinese lathes now available offer the same choices and the same problems to overcome.

The BW Electronics DRO System

A company called BW electronics used to advertise, in ME and MEW, a digital readout system which works on an entirely different principal of measurement to other systems. I have not seen any advertisements from them recently, but they do still sell these systems from their website



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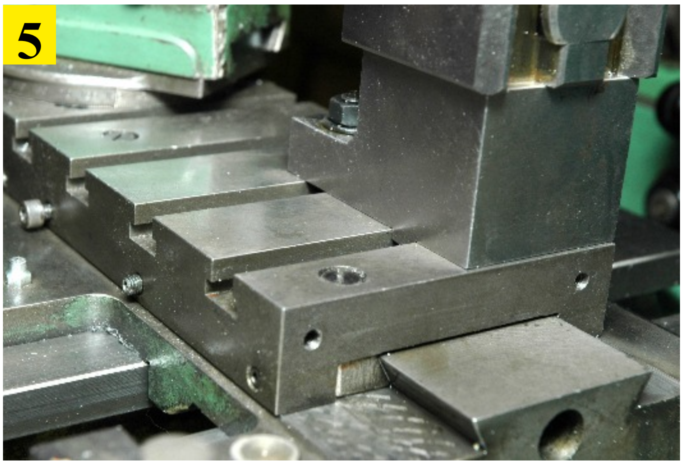
The Encoder Inside The Sensor



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The Holes In My Cross Slide

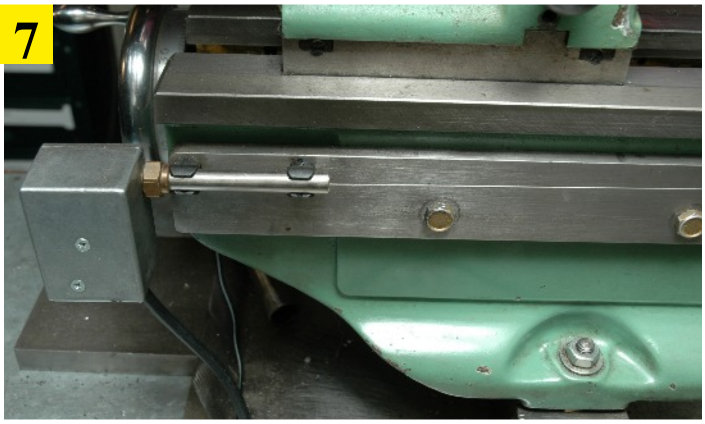
www.BWElectronics.co.uk . I have no connection with this company other than as a very satisfied customer, and I have found them to be most helpful to individual users.
I bought the BW 334 unit, which came complete with a panel, a power supply, and two sensors for around £400. The System is shown in **Photo.3** with just one sensor in the photo. The sensors work in an entirely different way to glass scales, in that an extremely fine stainless steel wire of 0.38 mm diameter (15 thou) is would round a rotating, spring loaded, drum in the sensor, and as the wire is withdrawn, the encoder measures the distance that the wire has been withdrawn. One big advantage is that the sensors come complete with clips to attach to the lathe and / or milling machine, so that the system can be switched between two machines in literally 30 seconds, providing you use the sensors as supplied. Now, DROs for both your mill and lathe for around £400 cannot be bad value in my opinion. My first reaction looking at the system was "Well – yes -, it sounds good in theory, but it cannot be accurate in practice". I have to say that I have found the system to be extremely reliable and accurate in practice over several year's use.
An added advantage of this system is that the wire can be wrapped around a groove on a drum on your simple dividing head and the sensor can be programmed to read whatever you like for a set distance. Set it to read 2540 for a full 360 Deg turn and then every reading of 20 will be the next tooth on your 127 tooth gear wheel. Dividing head AND DRO for close to £400 !! However, - I digress.
The sensors appear to be built with the precision of a Swiss watch and I have found them to be very robust. **Photo.4** shows the inside of one sensor, where the sprung winding drum and optical comparator disc are clearly visible.

The 334 display is fully featured and comes in a die cast box. The LED display is clear and the front keypad is wipe cleanable plastic. The unit in **Photo. 3** has been in constant use in my workshop for 5 or 6 years now.
The resolution of the display is 0.0005" or 0.005 mm and the display can be switched from imperial to metric and back at any time, maintaining correct readings. A "half" button allows readings to be divided by two, and the X reading may be set to read either radius or diameter for lathe use. Either axis can be either zeroed at any point or set to a defined reading through the keypad. Local or global readings may be displayed or set and the display switched at the press of a button. As already stated the sensors can be set to read in any user defined units and then easily returned back to the factory default. The readings are however lost on powering down the unit.

Fitting The DRO to My Lathe

Having decided that I would use the BW system, I looked at ways of clipping the sensors to both my lathe and my milling machine. Fitting to the milling machine was fairly straight forward and BW supply the small black pipe clips for attachment to more than one machine. The lathe, however, was another matter and I have used three separate methods of fitting the sensors to my lathe. Each system worked and I shall describe all three methods, explaining the advantages and disadvantages of each method.
Firstly I should explain that my lathe was bought pre-used, or second hand as it used to be called. When I looked round the back of the cross slide, I saw that there were two drilled holes in the back, as shown in **Photo. 5,** tapped 2BA, just as there are in the front of the cross slide to attach the lead screw. I assumed that these holes were there on all ML7 lathes, but it appears that this is not so and that someone had previously added these (or do you subtract holes !!) to my lathe. However they got there, I decided to use these for attachment of my cross slide sensor, and if the reader wishes to

The Sensor Overhanging The Taper Attachment.



The Z Direction Sensor Fitting

follow any of my examples exactly, it will be necessary to drill the cross slide. Of course, a bracket could be made to clamp between the rear T slot and the back of the cross slide, but my aim was to keep all T slots fully operational.

First Method of Fixing The X Direction Sensor

At first I attached the X direction sensor, by mounting everything at the back of the cross slide with the sensor overhanging the taper turning attachment cover, as shown in **Photo. 6.** I created a bracket to extend rearwards from the cross slide. The bracket was actually made from a piece of 1" x 5/8" strip with an 11 mm diameter bar set into it. This bar was milled flat on one side and the sensor clips attached, so that the body of the sensor was 16 mm from the back of the cross slide. Sorry for the mixed measurements, but it was made from metal from the oddments bin. The other end of the measuring wire was clipped to a small bracket attached to the existing suds bracket hole in the saddle. This worked well, and it is important to note that whilst I attached the sensor to the cross slide and the wire end to the saddle, it could just as easily have been attached the other way round. It is the **relative movement** between the two that we are measuring. This choice becomes more important when using glass scales or magnetic scales. These can also be mounted in a similar way, but the overhang is even greater. Disadvantages were that the overhang was considerable, and as I have very limited room at the back of my lathe, the sensor was always bumping into something as the saddle and the cross slide were traversed. The blue item is a cover for my surface plate – and that didn't move when it was in the way !! The second problem was that when the cross slide was withdrawn – i.e. for turning large diameters, the bracket covered the saddle clamping screw. In the photo that would happen if the cross slide was withdrawn any further.

The Z Direction Sensor

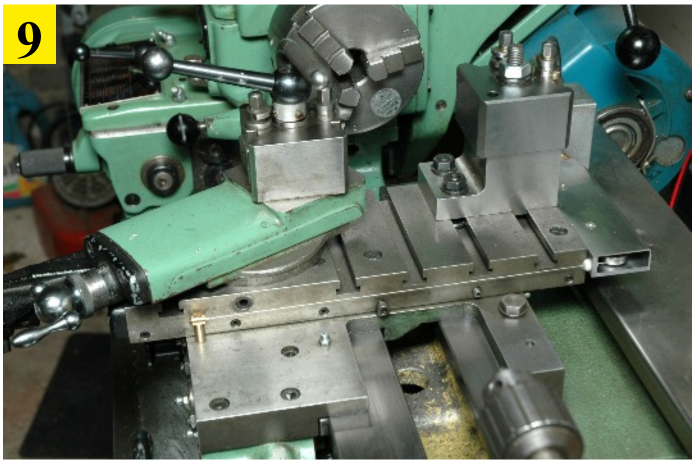
The Z direction was very simple to do on my lathe. There is a row of tapped holes at the back of the Myford lathe bed so that the Taper Turning Attachment may be attached at any point along the bed. In practice my TTA is permanently attached nearest the headstock and I have never had the need to move it. This leaves unused holes at the tailstock end and these were used to attach a plate carrying the Z sensor, as shown in **Photo. 7.** The other end of the wire was attached to the underside of the saddle by drilling the head of one of the saddle plate fixing bolts and inserting a small headed bolt on to which wire terminating ring terminal was hooked. The modified bolt is shown in **Photo. 8**. It is important when locating the two ends of the wire, that the run of the wire is exactly parallel to the lathe shears in both the horizontal and vertical plane, if the unit is to give 100% accurate readings. Making the head of the fixing bolt able to pass through the ring terminal, enables quick removal, and the wire tension keeps it firmly in place. The wire travels just beneath and behind the lathe bed shears, but over the top of the TTA. I could have covered the wire with a travelling cover attached to the saddle at the tailstock end, but the wire is well out of the way and in many years of use, I have only twice discovered a small piece of swarf hanging on the wire. The sensor has a PTFE wiper to assist in keeping the wire clean, and I have never found it necessary to cover it.

This method of attaching the Z sensor has stood the test of time, and I have never needed to modify it in any way.

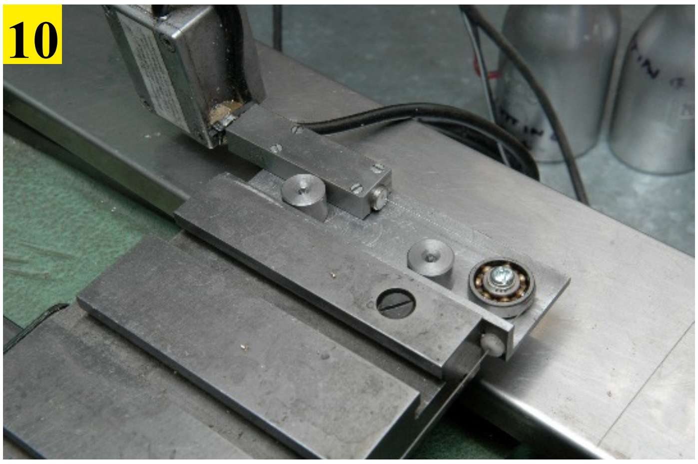
The Modified Saddle Plate Fixing Bolt

Second Method of X Direction Sensor Attachment.

Having bumped my overhanging sensor into various things at the



The Wire Passing Round a Bearing



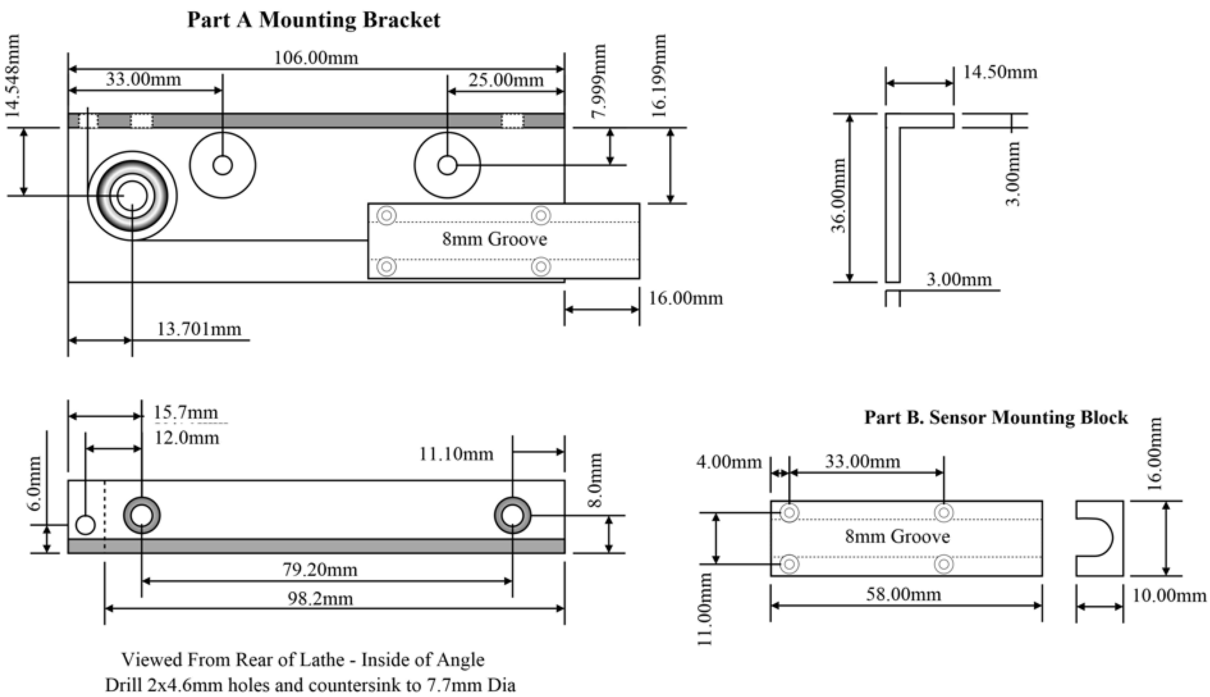
Sensor Mounting Details

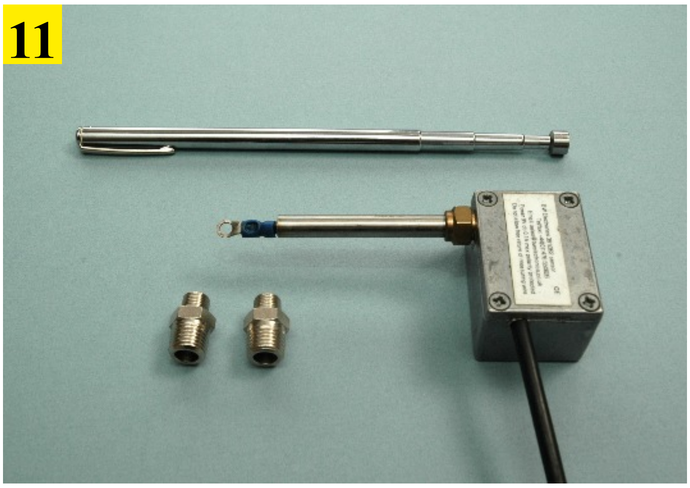
back of my lathe, I decided to try a more compact method of fitting this. No damage had taken place, and little inconvenience. However the perfectionist in me thought that the large overhang of the original system looked as though it was designed by a consortium of Heath Robinson and three cousins ! I therefore created a more compact system whereby the wire would travel around a small ball race and the sensor would be mounted at right angles across the back of the cross slide.

I had no idea whether taking the wire round a ball bearing would seriously reduce the accuracy, but I constructed the item shown in **Fig. 1** and it worked well, although it was slightly less accurate in use. By tapping the cross slide, I could get the reading to change by 1 thou – (0.0001”) on diameter, which represented a change in the length of the wire of 0.0005”. I could live with that for a while – and did use it like that for a year. The unit is illustrated in **Photo.9** and **Photo.10.** For those readers wishing to construct something similar, I have shown the drawing of my unit in **Fig.1.**

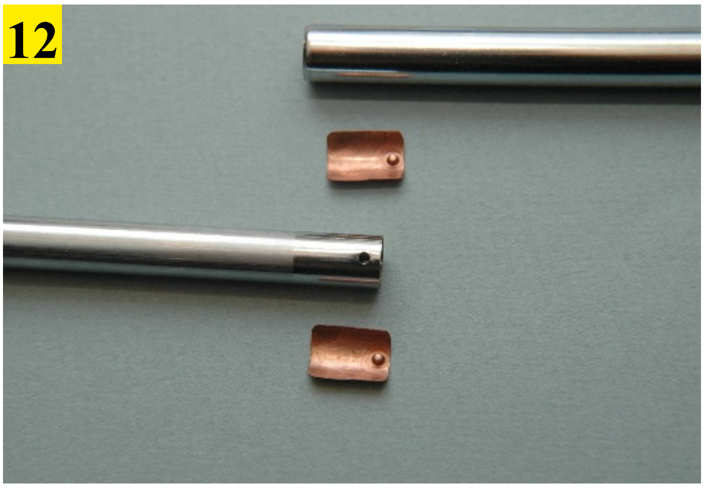
In order to mount the sensor in this way, it is necessary to remove the ring terminal from the end of the wire and to thread the wire through a home made PTFE wiper. I was fearful of doing this at first, but after several deep breaths and attaching TWO clamps to the wire to

Fig. 1 Rear Cross Slide DRO Mounting





The Sensor and Magnetic Wand



Friction Pads on Telescopic Section

stop it retreating into the unit, the wire was threaded up and the new terminating end was attached to the wire.

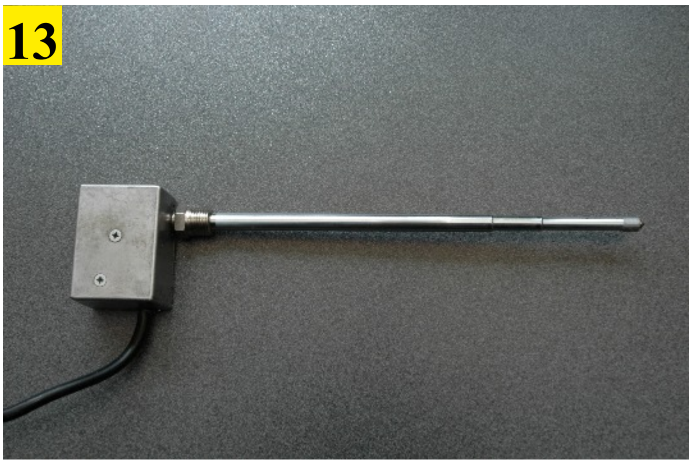
In **Photo.9** you will see that I drilled the front of the saddle and fitted a post using a 6BA bolt. This post holds the end of the measuring wire. The sensor is mounted at the back of the cross slide as shown in **Photo. 10** and the wire is passed round a small ball bearing and then through a PTFE grommet to stop swarf from entering the bearing area. The end cap was removed in **Photo. 9** for clarity and the entire cover was removed in **Photo.10**. You can see that The wire is clear of all the T slots and of the gib strip adjusting screws. It was however necessary to exchange the bolts which hold the top slide in place, for grub screws, as otherwise the original bolts fouled the wire retaining pillar when the top slide was withdrawn.

This system worked well and was perfectly accurate for my needs, although I never quite trusted it as much as a straight wire path. The wire was left unprotected as I never got round to making the clip on cover that was originally intended. As a result, I did have to occasionally clean the wire when I was making a lot of swarf or using a lot of cutting oil. (I use neat cutting oil and do not use suds) The main problem with this system, for me, was that I use collets a lot and when working right up against the headstock, the sensor body tended to get in the way of operating the belt changing lever. This is the large black knob in the upper right corner of **Photo. 9**. The sensor body had to extend to the left of the cross slide in order not to foul the saddle. This is, however a very workable solution and I used it for perhaps a couple of years.

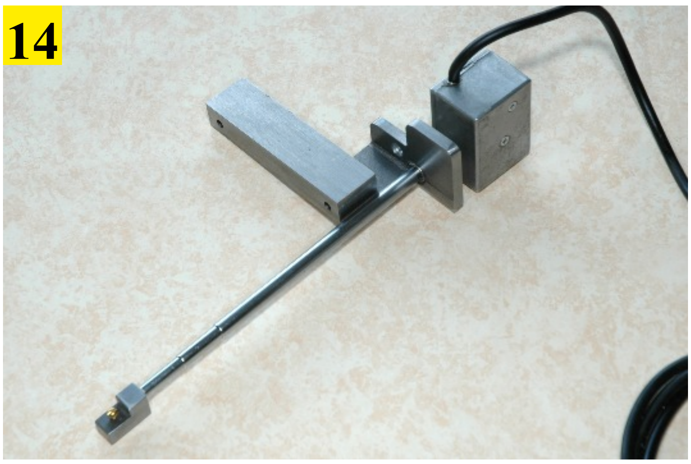
The final solution for the X Sensor

My thoughts turned to making a system with a straight wire path, but where the wire was protected and enclosed in a telescopic guide tube. My cross slide had a maximum travel of 160 mm from fully out to fully in. The general layout of the cross slide is shown in **Fig. 2** and this showed me that if I were to fit the tube below the level of the T slots, but above the level of the gib strip adjusting and clamping screws, then the tube must have a maximum diameter of no more than 8mm, and that the centre of the tube must be exactly at 14 mm from the top surface of the cross slide. The same restrictions would apply if I were to fit a more conventional DRO similar to the Newall system.

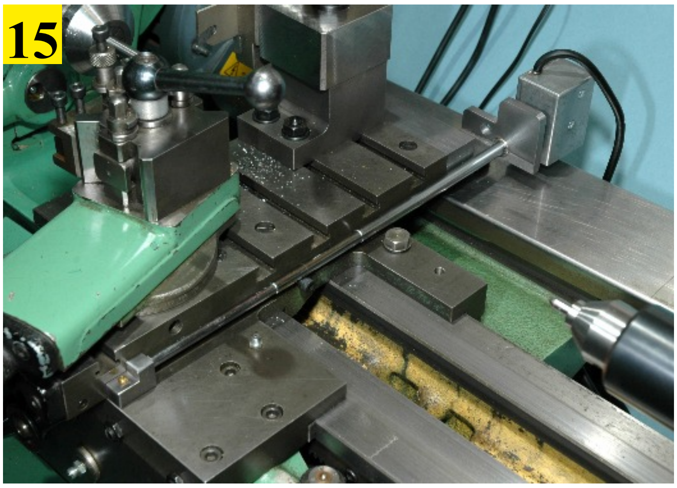
I thought about making my own telescopic guide tube system using stainless steel tube, and then I rapidly lay down until the feeling went away. I looked at telescopic radio aerials and these are cheaply available from radio spares suppliers.



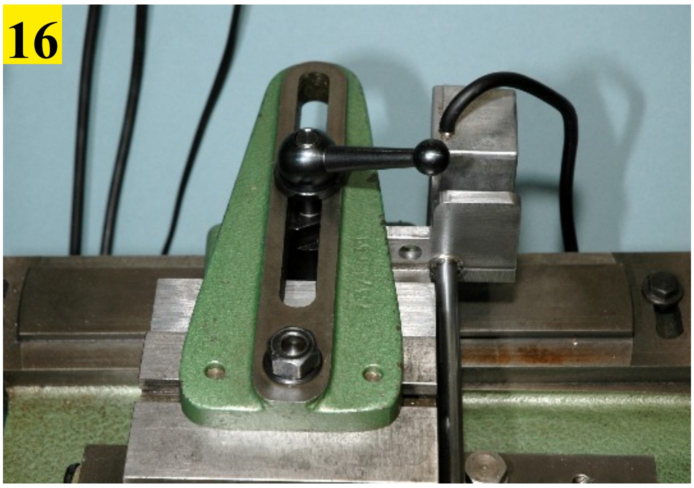
The Finished Guide Tube



Attachment Brackets Added



The Guide Tube Fitted To The Lathe



Using With a Taper Turning Attachment

Some however are very thin and flimsy. Finally my eyes came to rest on the magnetic part retriever (wand) that I used for retrieving those parts that walk under the bench from time to time (entirely on their own I may add). This wand extended to around 500 mm and reduced to 125 mm, having 4 telescopic sections – see **Photo. 11, -** the outside tube was however 9 mm diameter. I estimated that, on my lathe, the tube need only extend to around 350 mm and collapse to 175 mm, so a 3 tube "telescope" would be perfectly adequate for my needs.

Adapting The Sensor

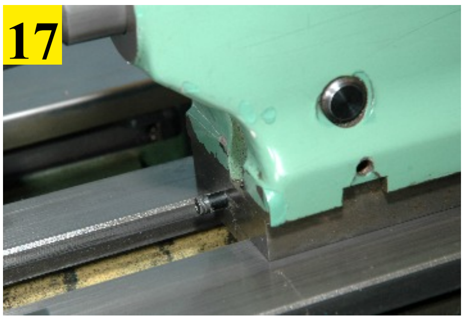
On removing the pocket clip from one end of the "wand", and the magnet from the other end, it is possible to push the individual sections through each other to disassemble the telescopic section. The sections are held together by friction pads as shown in **Photo. 12** and I considered that the wand was a little stiff in action. The friction pads were sanded with wet or dry paper and lubricated with thin oil until the friction needed to extend the wand was just right, and the whole thing was assembled again. Removing the outer 9 mm tube left me with three sections of 6, 7 and 8 mm respectively. The thread on the sensor box is 1/8" BSP, so a 1/8" to ¼" BSP reducing nipple was purchased and this was fixed on to the end of the wand with Loctite. I intended to bore out the reducing nipple to be a tight sliding fit on the 8 mm tube, but this proved to be unnecessary as it was already a tight sliding fit as supplied.

With a cup of calming tea, and with soothing music playing in the background, I nervously removed the existing guide tube from the sensor, clamped the wire firmly at the sensor side of the tube and removed the wire end stop yet again. The wire was then threaded through the new telescopic tube and through a hollow rivet which was just too large to pass through a hole drilled at the narrow end of the tube. A knot was made in the end of the wire so that it could not pass through the rivet, and it was then safe to remove the wire clamp and to screw the telescopic guide tube into the sensor. The end of the wire was Loctited prior to cutting to stop strands unravelling. The result can be seen in **Photo. 12** and you will see that I have temporarily placed a small piece of tape onto the end, so that it is impossible to push the small diameter tube too far in.

The attachment brackets have been added in **Photo. 14** and you will see that the sensor will attach to the rear of the cross slide, whilst the end of the tube will attach to the front section of the top of the saddle. For the eagle eyed readers who noticed the extra hole in the bracket, it is there to allow the 2BA setscrew to be passed through the rear mounting block and to allow it to be tightened by a long hexagonal key.

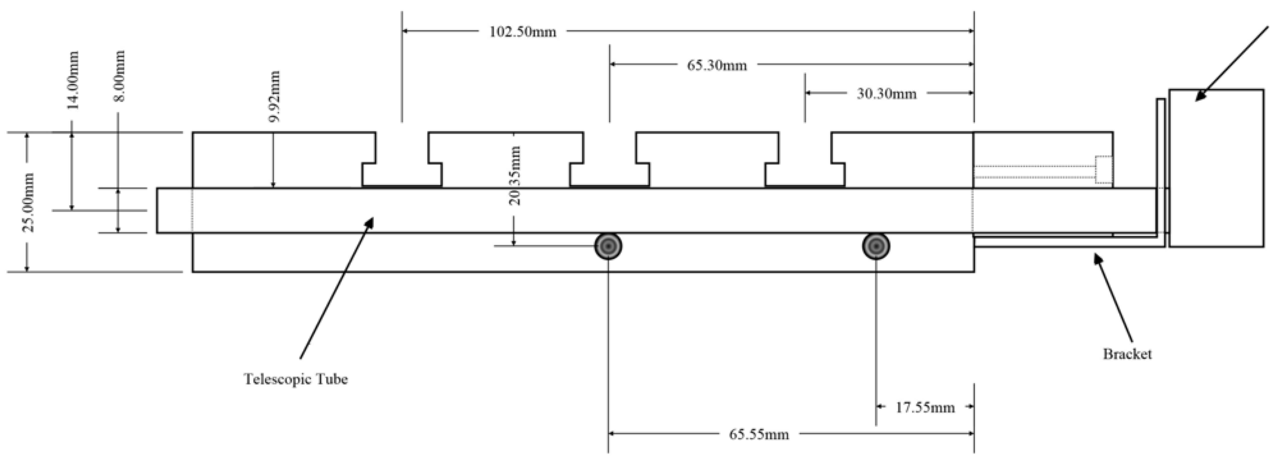
Great care was taken in the making of the above bracket, as the centre height of the tube had to be EXACTLY 14 mm from the top surface of the mounting block and cross slide. Also the horizontal position of the centre of the tube was made to be 5 mm from the edge of the mounting block, so that cutting fluid would be able to run down the 1 mm gap between the cross slide and the larger guide tube.

Once the X direction sensor was bolted to the lathe, it looked completely unobtrusive see **Photo. 15**. It does not hinder the use of the lathe in any way whatsoever and is proving to be an absolutely superb accessory. It does make the saddle clamp slightly more difficult to use however, as I cannot fit a socket spanner to it, and I shall probably make an extended clamping handle to overcome this. **Photo. 16** shows the DRO being used with a taper turning attachment, where it is not in the way. Using a DRO makes



Tailstock Stop

Fig. 2 Telescopic Tube Cross Slide DRO Mounting



setting a TTA an absolute dream. Set both readings of the DRO to zero, wind on the saddle by 100 mm, read the X reading and work out the angle. Do however be careful as to whether the DRO is reading radius or diameter when doing this.

I have lost only 10 mm of tailstock movement by fitting the DRO and **Photo. 17** shows that I have fitted a stop to the tailstock by drilling the sliding section and tapping 4 mm for a tailstock stop. This extends only 10 mm and protects the DRO by causing the tailstock to hit the saddle, whilst leaving a gap of 10 mm for the DRO tube.

Not every reader will have a Myford and not every reader will wish to use the BW system of DRO. However I hope that I have indicated some of the questions that need to be answered before laying out money on a DRO system which will probably be complicated to fit on a small lathe. The advantage of the BW system is that it telescopes. A glass scale, fitted to the cross slide will always be at the maximum length required, and with (say) 160 mm of cross slide travel, it is amazing how long a glass scale needs to be, if you are to keep the reading head away from the crowded area in the centre of the lathe bed.