Harris Intermediate Spectrometer Q62050/8

USER MANUAL

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SETTING UP AND ADJUSTMENT OF THE HARRIS INTERMEDIATE SPECTROMETER. Q62050/8

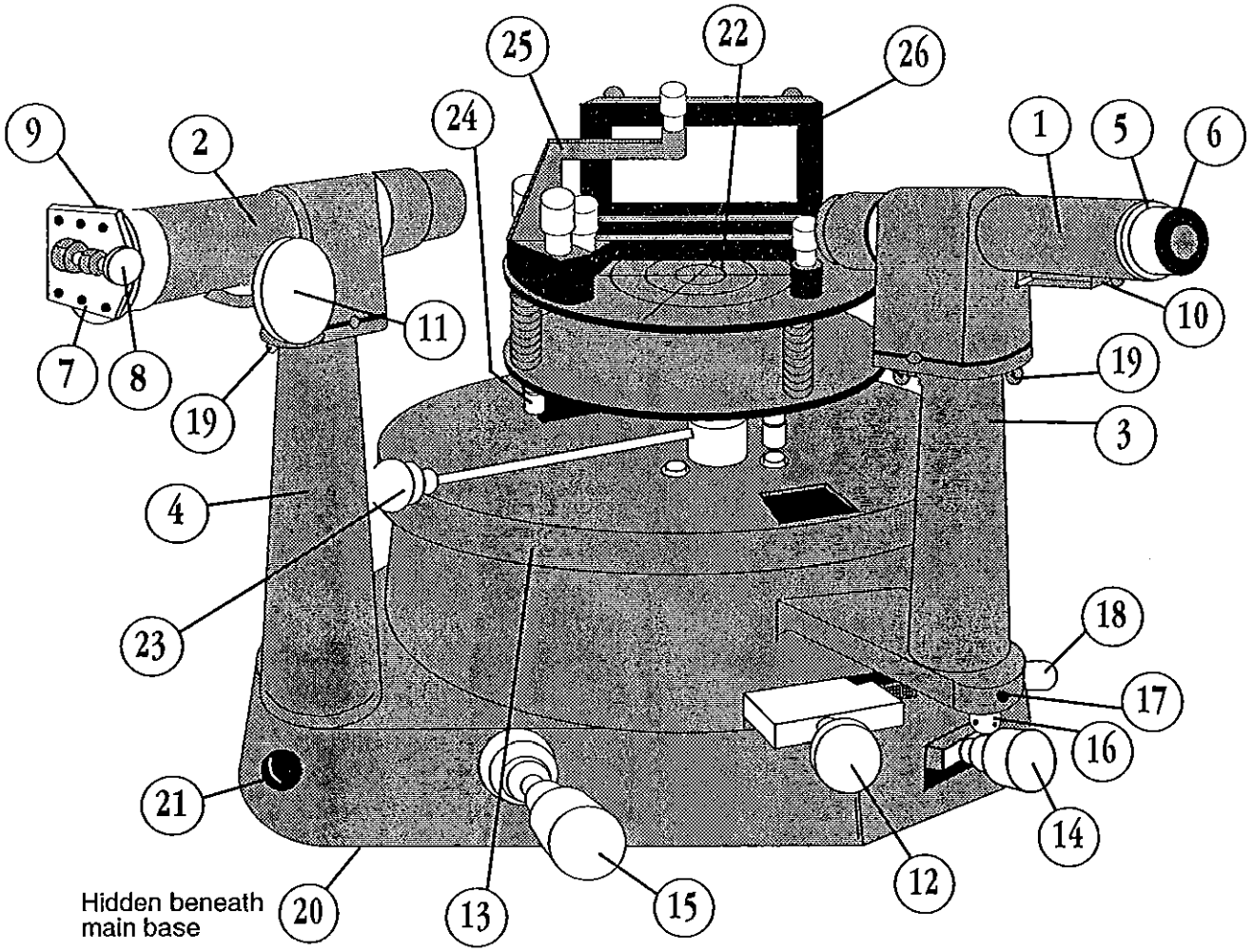
INTRODUCTION

Major mechanical setting up was carried out before this spectrometer left the factory. However, these notes are included as guidance for the user, to enable them to check their instrument, perform the pre-experiment focusing procedure and, if necessary, make their own final adjustments to ensure optimum performance in use. Mechanical adjustments do not normally have to be carried out on any regular basis, and should not need to be repeated unless-the instrument has, for example, been dismantled for any reason, or has had replacement parts fitted.

Experimental procedures as such are not covered. Because spectrometry is a standard and very 'traditional' area of optical science, appropriate experimental methods are covered in detail in many text books, and it is therefore assumed that if guidance of this nature is required, the user will refer to an appropriate text . Two currently available works, both of which include chapters on spectrometry are:

'Practical Physics in S.I.' by E Armitage, published by John Murray
AND
'A Laboratory Manual of Physics' by F Tyler, published by Arnolds

A component identification diagram is given below to help the user in locating the various functional parts of the instrument as they are mentioned in the text which follows, and during subsequent experimental work.



INTERMEDIATE SPECTROMETER
COMPONENT IDENTIFICATION

1. Telescope tube
2. Collimator tube
3. Telescope support pillar
4. Collimator support pillar
5. Crosswire orientation adjustment ring
6. Eyepiece
7. Slit assembly
8. Slit width adjusting screw
9. Slit orientation locking ring
10. Telescope main focusing control (behind telescope)
11. Collimator focusing control
12. Telescope position coarse adjustment locking screw
13. Main table (enclosing main scale)
14. Main table rotation coarse adjustment locking screw
15. Main table rotation fine adjustment locking screw
16. Telescope alignment adjusting screw (horizontal plane)
17. Telescope pillar locking bolt
18. Telescope/scale fine adjustment control
19. Vertical axis adjustment screws (2 for the telescope, 2 for the collimator)
20. Collimator alignment adjusting screw (horizontal plane)
21. Collimator pillar locking bolt
22. Prism table
23. Prism table locking screw
24. Prism table levelling screw (3 of)
25. Prism clamp
26. Diffraction grating holder

Note 1 Item 10 is the large knurled head screw which, in the diagram, is largely hidden behind the telescope tube 1.

Note 2 Item 20, the collimator alignment adjusting screw is not visible in the diagram as it is beneath the main base.

Note 3 For the purposes of component identification, both the diffraction grating holder, 26, and the prism clamp, 25, are shown mounted on the prism table, 22. In practice of course, only one or the other would be fitted at any one time, depending upon whether a diffraction grating or prism were being employed.

SETTING UP AND ADJUSTMENT

1. Optical Adjustment of the Telescope

1.1 Place the spectrometer on a table or bench near a window which provides an uninterrupted view of a reasonably distant object such as a tree, building etc. Ideally the object should be at least 100m distance, but acceptable results can be achieved at distances down to 40 to 50m. The reason for this part of the procedure is, of course, that the more distant an object is, the more nearly parallel are the light rays received from it, and it is necessary to have the telescope adjusted to accept and bring to a focus parallel light entering its objective lens.

1.2 Position the spectrometer so that the telescope is directed towards the chosen object, but with the collimator and prism table components out of the line of sight. This will probably involve swinging the telescope around using its coarse position adjustment. To do this it may be necessary to slacken the telescope coarse adjustment locking screw, 12.

Note For the telescope position fine adjustment screw, 18, to function correctly, the coarse adjustment locking screw, 12, must be tight.

1.3 Look through the telescope. An image of the crosswires should be visible, and possibly of the distant object as well, although at this stage both will probably be out of focus to a greater or lesser degree. Firstly, bring the crosswires into sharp focus by sliding the moveable part of the eyepiece in or out. If the cross is not accurately perpendicular, rotate the crosswire orientation adjustment ring, 5, as required.

1.4 To bring the distant object into focus adjust the telescope focusing control, 10, as required. Superimposed sharp images of the distant object (inverted) and the crosswires should now be apparent, indicating that the telescope as a whole is correctly focused.

2. Optical Adjustment of the Collimator

2.1 Reorientate the spectrometer components to bring the telescope and collimator into line with each other across the table.

2.2 Open the slit a little using the slit width adjustment screw, 8, to make it more easily visible and look through the telescope. An image (probably unfocused at this stage) of the slit should be seen. If necessary move the telescope from side to side a little to bring the slit into the centre of the field of view.

2.3 Focus the image of the slit by adjusting the collimator focusing control, 11, until its edges are sharply defined. Once this is done, the slit may be closed down to a more normal working width (naturally, the telescope focusing should not be disturbed during this procedure).

2.4 Using the telescope position fine adjusting screw, 18, centralise the image of the slit on the crosswires. The image should, of course be parallel with the vertical of the cross. If not, slacken the slit orientation locking ring, 9, rotate the slit assembly, 7, as required and retighten the screw.

Optical adjustment of the spectrometer is now complete and the instrument is ready for use. Normally these are the only adjustments that a user will need to carry out, at least on anything approaching a regular basis.

Major mechanical alignment of the principle components should be found to be sufficiently accurate as supplied for all normal use. However, the procedures given below are included to enable users to check their instrument if desired and, should they consider it necessary, to carry out fine adjustments for themselves. Essentially, this involves ensuring that the optical axes of the telescope and collimator lie in the same horizontal plane and can be made coincident with each other and that this plane is parallel to the surface of the main table, 13.

Finally, the prism table, 22, may be checked and, if necessary, adjusted to ensure that its own top surface is also parallel to that of the main scale table.

3. Checking and Adjustment of the Optical Axes

3.1 Position the telescope and collimator so that they are diametrically opposite each other, and the spectrometer as a whole directed towards a window or other light source.

3.2 Look through the telescope and, using the coarse or fine positioning facility centralise the image of the slit on the cross wires. This will ensure that the telescope and collimator are as accurately in line with each other as possible.

3.3 Take a straight edge, about half a metre long, eg a good quality half metre rule, together with a smaller, reasonably finely divided rule having graduations right to its end. An engineers 150mm steel rule would be ideal. Lay the straight edge, edge on, across the tops of the telescope and collimator. Obviously, the straight edge will not make contact with these components along their full lengths, but will rest on the highest points of their bodies, leaving a gap of about 5mm between itself and the parallel portions of the body tubes. However, it can be seen that if the telescope and collimator axes are coincident this gap will be constant along their upper surfaces. This can be checked by standing the small rule vertically on each tube in turn at a couple of positions. If all measurements are effectively the same it can be concluded that the axes of the two tubes lie in the same horizontal plane.

3.4 To check that this plane is parallel to the surface of the main scale table, leave the straight edge in position and measure its vertical distance from the surface of the table at points just in front of the telescope and collimator respectively. Again, the two measurements should be equal.

3.5 If, on having made the above measurements, it is felt that adjustment is required, this may be accomplished by tilting the telescope and/or collimator in the appropriate direction by means of the axis adjustment capstan screws, 19.

The direction in which to tilt a tube, and consequently which screws to slacken and which to tighten should be self-evident from consideration of the physical arrangement of the spectrometer components. For example, if measurements taken suggest that the optical axis of the telescope should be tilted downwards towards the table, it will be necessary to tighten the front screw and slacken the rear by the same amount. The process should be carried out in steps of not more than an eighth of a turn at a time, checking and repeating as required until the necessary amount of movement has been introduced. The capstan screws are turned by means of a small tommy bar which is supplied with the spectrometer.

3.6 Repeat the checks in steps 3.3 and 3.4 to ascertain that the required degree of correction has been achieved.

Finally, sight through the telescope/collimator system to check that the optical alignment is still in order. If it is found that the axis adjustments have introduced a vertical displacement between the slit image and the crosswires, further careful fine adjustment of the capstan screws, performed whilst sighting through the telescope and collimator should permit it to be returned to the correct position.

3.7 If desired, a check may be carried out to ascertain that the axes of the telescope and collimator (and therefore their common axis when they are diametrically opposed) both pass over the central point of the prism table. It has to be said that this is not an easy parameter to check with any great precision, although fortunately the possibility of there being any errors requiring correction in this department is remote unless the spectrometer has been dismantled, or its components disturbed in any way.

From experience, it has been found that probably the simplest way of making this check, which is nevertheless sufficiently accurate for most practical purposes is to proceed as follows:

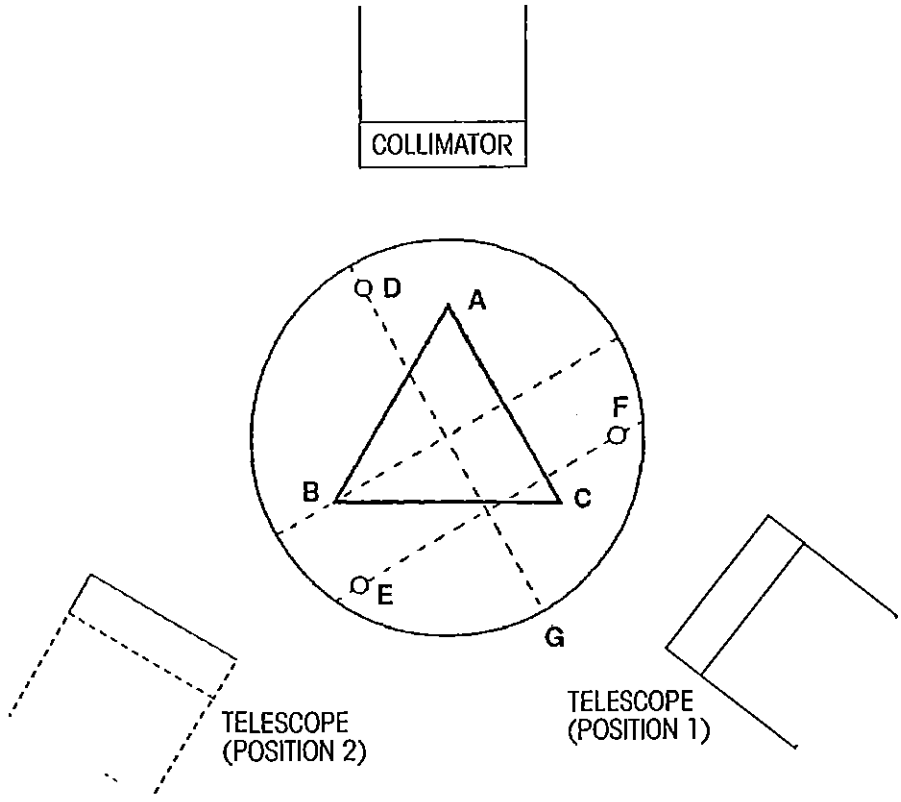
Firstly, it is necessary to have two people involved. With the telescope and collimator diametrically opposed (ie the positions that they will be in after completion of step 3.6), take a length of fine thread and stretch it along the tops of the telescope and collimator. Take particular care to ensure that, as far as can be achieved, the thread lies directly over the optical axes by carefully sighting from above the spectrometer. The second person should then take a small set square, place it upright on the prism table and very carefully bring it up to the stretched thread so that its vertical edge just makes contact. It can thus be seen that if the thread, and therefore the common optical axis is directly over the prism table centre, the right angle corner of the set square will also coincide with the centre of the prism table.

In the unlikely event that adjustment is deemed necessary, it is carried out by rotating the support pillars of the telescope and/or collimator (3 and 4) to the required degree. The two Allen-head locking bolts, 17 and 21 should first of all be slackened and then the horizontal alignment capstan screws, 16 and 20. The components may then be rotated as required. As with the vertical axis adjustment, examination of the physical arrangement of the components should make it obvious in which direction and to what extent rotation is required. Once this is done the screws may be retightened and the thread/set square check repeated. Naturally, if adjustment has had to be carried out, the relative overall positions of the telescope and collimator required to produce coincident optical axes will have to be readjusted. The telescope find adjustment control, 18, will provide a more than adequate range of movement for this purpose.

4. Levelling the Prism Table

One final procedure that the user may be called upon to carry out on occasion is the checking and, if necessary, levelling of the prism table, 22, by means of the prism table levelling screws 24. The purpose of this is to ensure that the optical face(s) of a prism or diffraction ,rating, when installed on the table is/are truly perpendicular to the horizontal plane in which the paths of the light rays through the collimator/telescope system must lie. This in turn ensures that rays from the collimator remain in this plane after refraction or diffraction and are thus properly received by the telescope.

4.1 Examine the surface of the Prism table. It will be seen that it has three straight lines engraved upon it. Two of these are diameters, perpendicular to each other, one of which passes through the axis of the levelling screw marked D in the diagram below. The third line passes through the axes of the other two screws (E and F). The concentric circles are simply guides to aid in the positioning of items on the table.



4.2 Take an equilateral (60°x 60°x 60°) prism - represented by triangle ABC in the diagram - and set it on the prism table so that one of its faces (AC) is parallel to the diameter line which passes through levelling screw D, i.e: line DG.

4.3 Orientate the prism table and collimator as shown in the diagram and illuminate the slit. The relative positions of collimator and prism should be such that light from the collimator impinges simultaneously on faces AB and AC, and two images of the slit can therefore be seen, by reflection, one from face AB and the other from face AC. To achieve this vertex A should point directly at the collimator and the distance between A and the collimator lens adjusted until the required double image situation is achieved. This is best carried out initially with the naked eye, i.e. without using the telescope. The important thing to bear in mind is that whatever final position the prism occupies, face AC should always be maintained parallel to line DG.

4.4 Move the telescope into position 1 as shown on the diagram and adjust it until it picks up the image of the slit that is reflected from face AC. If necessary make further line adjustments to the position of the prism.

4.5 If the above procedure permits the image of the slit to be correctly centered and positioned on the telescope cross wires, then the face of the prism represented by line AC is perpendicular to the plane of the light rays and the operator can pass directly to step 4.6. If not, carefully adjust either or both of the screws E and F whilst sighting down the telescope until the image of the slit is in the required position. Reference to the diagram will show that movement of either of these two screws will have the effect of rotating the prism table about an axis represented by line DG, thus tilting the face AC of the prism backwards or forwards as required to achieve the required perpendicularity. It can also be seen that screw D would have no effect as, due to the parallelism between AC and DG movement of D would simply rotate the reflecting face of the prism in its own plane without changing its orientation relative to the incident light beam.

4.6 Move the telescope around to position 2 and this time adjust the component orientation to pick up an image of the slit reflected from face AB of the prism. Centralise this image by adjustment of screw D only. Do not touch screws E or F during this process and ensure that AC and DG are kept parallel.

4.7 With the image centralised for position 2 return the telescope to position 1 to ascertain that the situation achieved as a result of carrying out steps 4.3 to 4.5 still obtains. If not, make further adjustments to screws E and F to correct any misalignment.

It may be necessary to alternate between telescope positions 1 and 2 several times, making appropriate fine adjustments to the levelling screws as necessary. However, a state of affairs should finally be reached where a centralised, correctly aligned image of the slit can be seen at both positions of the telescope without the need for 'between position' table adjustment. Once this state of affairs is reached the table can be considered to be accurately level on all axes.

Servicing Note:

After an extended period, the scale and vernier may become dirty or tarnished, and consequently difficult to read. They may be restored by the gentle use of a good quality non-abrasive metal polish such as Dura-Glit etc. To gain access to the scale, slacken the prism table locking screw, 23, and remove the prism table itself (22). It will be seen that there are two screws in the top of the main table, 13, positioned one either side of the prism table mounting boss. If these screws are removed, the main table, which forms a cover over the scale, may be lifted off, thus exposing the scale itself.