CHAPTER 7
AXES ALIGNMENT PROCEDURE

CONTENTS

7-3 Machine build-up

7-3-1 Machine build-up: Y-Axis

7-3-1-1 Y-Axis: Y-Axis spindle

The Y-Axis ball spindle has a fixed position in the system. Therefore, the position cannot be adjusted. The bearings are placed on both ends of the spindle and are then placed in the housing (or vice versa). The bearing housings are secured on the right axis stand in the machine. The bearing housing is best located when set completely in the corner of the fixing position in the frame (see blown-up picture).
The right linear guide (front view) is marked 'Z3' or 'KL', specified at the end of the type number marked on the guide itself.

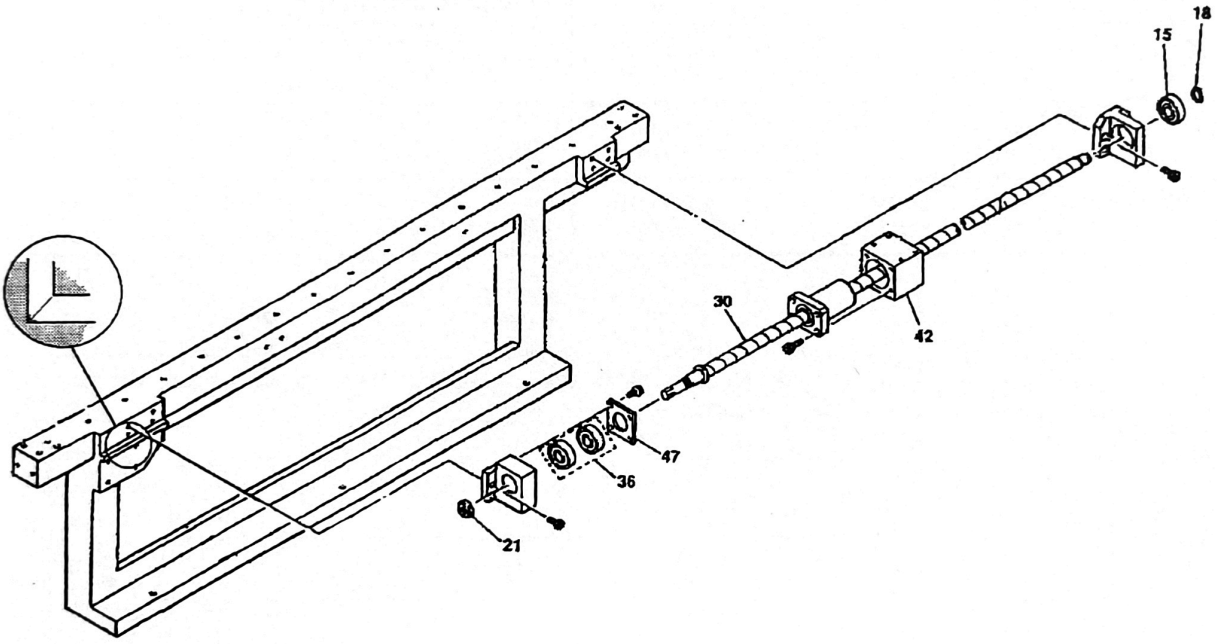


Fig. 7-2
Y-Axis ball screw attachment.

7-2 Specifications

After the whole machine has been built-up, the machine must comply with the following specifications regarding linearity and perpendicularity. See table 2.0. and figure 2.0. The parallelism of the Y-axis should be within 0.03 mm over the whole length.

✎ NOTE !

The specifications after the whole machine has been built up **differ** from the tolerances that should be taken care of during building up. All tolerances add leads to the values specified in the table below:

Machine	Axis	Travel Length	Linearity	Right Angle	Parallelity X-Axis - Conveyor
HSD	X-Axis Y-Axis	≥620 ≥595	≤0.1mm/620mm ≤0.05mm/595mm	≤0.1 Area: 460x407mm	≤0.1mm/460mm
CSM66	X-Axis Y-Axis	≥530 ≥385	≤0.1mm/530mm ≤0.05mm/385mm	≤0.1 Area: 330x250mm	≤0.1mm/330mm
CSM84	X-Axis Y-Axis	≥620 ≥595	≤0.1mm/620mm ≤0.05mm/595mm	≤0.1 Area: 460x407mm	≤0.1mm/460mm
CSM84V	X-Axis Y-Axis	≥620 ≥595	≤0.1mm/620mm ≤0.05mm/595mm	≤0.1 Area: 460x407mm	≤0.1mm/460mm
CSM84VZ	X-Axis Y-Axis	≥620 ≥595	≤0.1mm/620mm ≤0.05mm/595mm	≤0.1 Area: 460x407mm	≤0.1mm/460mm

Table 7-1 Linearity and perpendicularity tolerances after machine build-up

An example of the deviations and tolerances is given in the figure below. Take note that only the values for the CSM66 differ from what is mentioned in this figure. For the correct values, see table above.

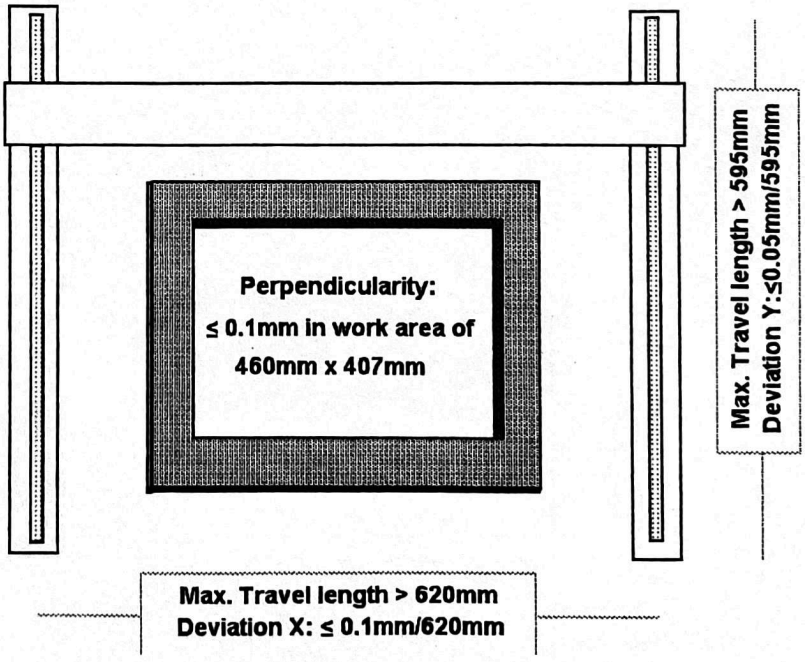


Fig. 7-1 Linearity and perpendicularity.

7-1 Introduction

Conditions:

- It is assumed that persons who use this adjustment procedure are familiar with the CSM equipment. They must have attended an operator training, a user training and a service training.
- These adjustments are only meant for the following systems:
  1. CSM66
  2. CSM84
  3. CSM84V
  4. CSM84VZ
  5. HSD
- The adjustments are written to align the X and Y axes.
- The adjustments are not written to do calibration for a machine that was just assembled in the production department of the machine manufacturer.

The alignment procedure only explains the alignment methods that should be used to guarantee a straight axes system. It will not describe in detail how to remove cabling, adjust belt tension, how to remove bolts etc. The procedure is only necessary to verify and adjust axes linearity and perpendicularity after a serious crash has occurred with the system.
After the alignment of the axis, realignment of the feederbars may be necessary as described in the previous chapter 8.

Occurrences:

If a crash occurred, one of the following four situations are most likely to happen:

Situation 1: The bolts that hold the Y-Axis linear guides get loose and misalign the Y-Axis. Of all situations, this is the least possible to occur.

Situation 2: The bolts that hold the X-axis frame to both Y-axis linear guides* are loose.

Situation 3: As with situation 2, the bolts are not really loose, but the X-Axis frame has moved underneath these bolts and is now dislocated.

Situation 4: The X-Axis linear guide or spindle shows a dip (=not straight anymore).

Situations 2 and 4 are most common. It is advised to check and correct (if applicable) these situations first before continuing any other action. It is possible that a combination of one or more situations has occurred. The chance that the Y-Axis linear guides or spindle are deformed is considered very small. The impact of the head in X-movement, which could cause this, is low.

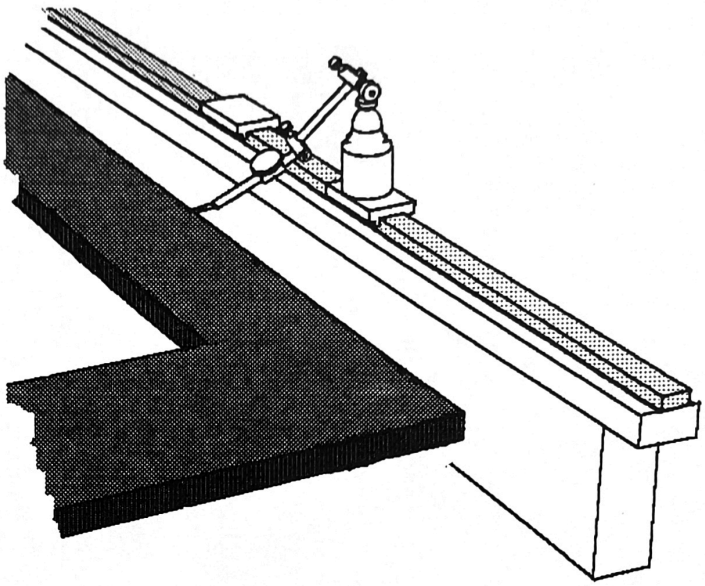


Fig. 7-5
Aligning the right linear guide.

Step 9. Move the bearing with the dial gauge to the other end and set the straight ruler to the same distance. At both ends the ruler has the same distance to the linear guide.

Step 10. Go to the middle of the linear guide and adjust the position of the guide to be within 0.01mm of the measured distances of step 8 and 9. Tighten the bolt.

Step 11. While moving the bearing towards the end or front, set the straightness within 0.01mm tolerance and tighten the bolts on the way. See figure 7-6. The figure shows the following adjustment:

1. Set a fixed distance 'x' (can be any distance), tighten the bolt here.
2. Set same fixed distance 'x'. Now both ends have the same distance to the ruler. Tighten the bolt here too.
3. In the middle of the linear guide, set the same distance 'x'. The tolerance of the whole guide is _0.01mm from the distance 'x'.
4. Between the middle (3) and rear end (1), fix now slowly every bolt if the distance 'x' is within tolerances.
5. Same as 4. for the other half of the linear guide.

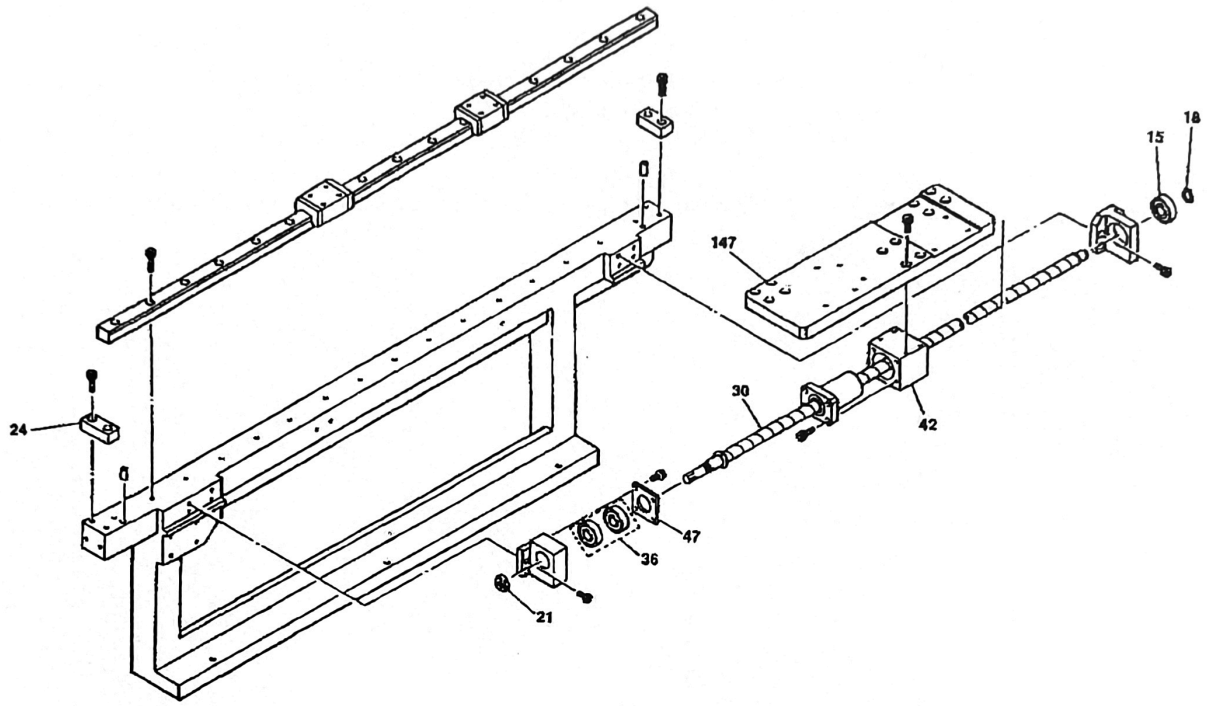


Fig. 7-4
Connecting the guide to the ball screw.

Step 3. Move the bearings as far as possible to the rear of the system.

Step 4. Press the linear guide against the positioning pin as much as possible and tighten the bolt at this side of the guide (see blown-up part of figure 7-3.)

Step 5. Move the bearings as far as possible to the front of the system

Step 6. Press the linear guide against the positioning pin as much as possible and tighten the bolt at this side of the guide.

Step 7. Remove the plate 147 from the bearings.

Step 8. Place a straight ruler parallel to the linear guide and measure the distance via the dial gauge. See figure 7-5.
The ruler can be placed on the conveyor rails and is heavy enough to make fixing unnessecary.

7-3-1-2 Y-Axis: Right linear guide

The right linear guide (front view) is marked 'Z3' or 'KL', specified at the end of the type number marked on the guide itself.

Step 1. Place the right linear guide on the stand. Insert all bolts, but do not tighten.

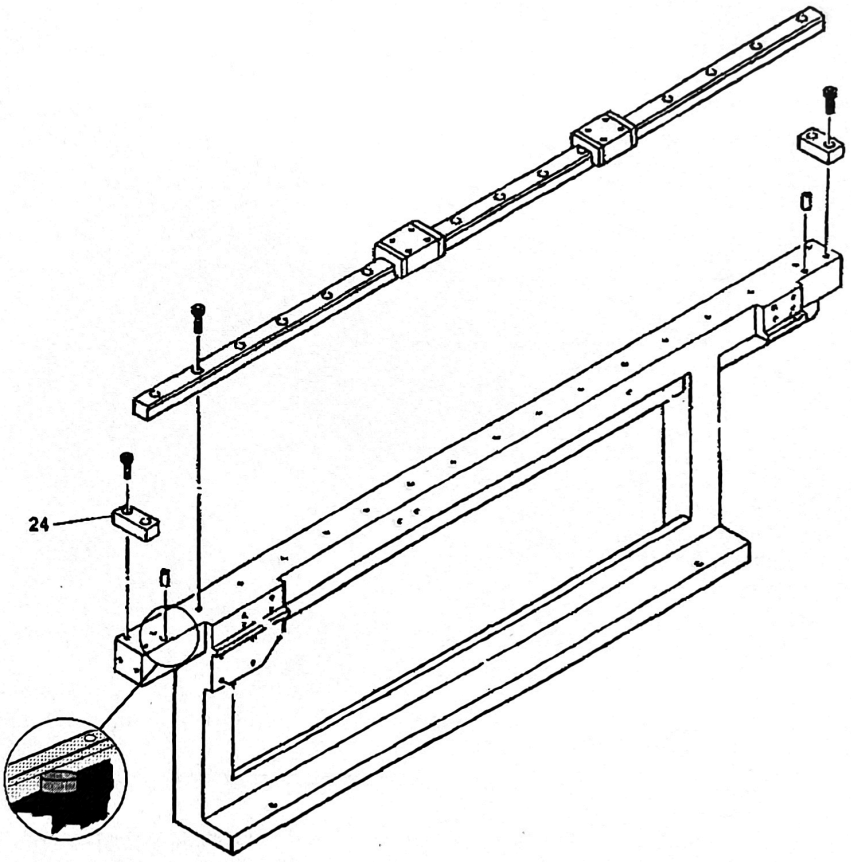


Fig. 7-3
Right linear guide attachment.

Step 2. Attach plate 147 to the bearings of the ball screw and linear guide. See figure 7-4.

7-3-2 Machine build-up: X-Axis

7-3-2-1 X-Axis: X-Axis Spindle

The X-Axis ball spindle has a fixed position in the system. Therefore, the position cannot be adjusted. The bearings are placed on both ends of the spindle and are then placed in the housing (or vice versa). The bearing housings are secured on the X-axis beam. Set the bearing housing against the edge as much as possible as shown in the blown-up part of figure 7-9.

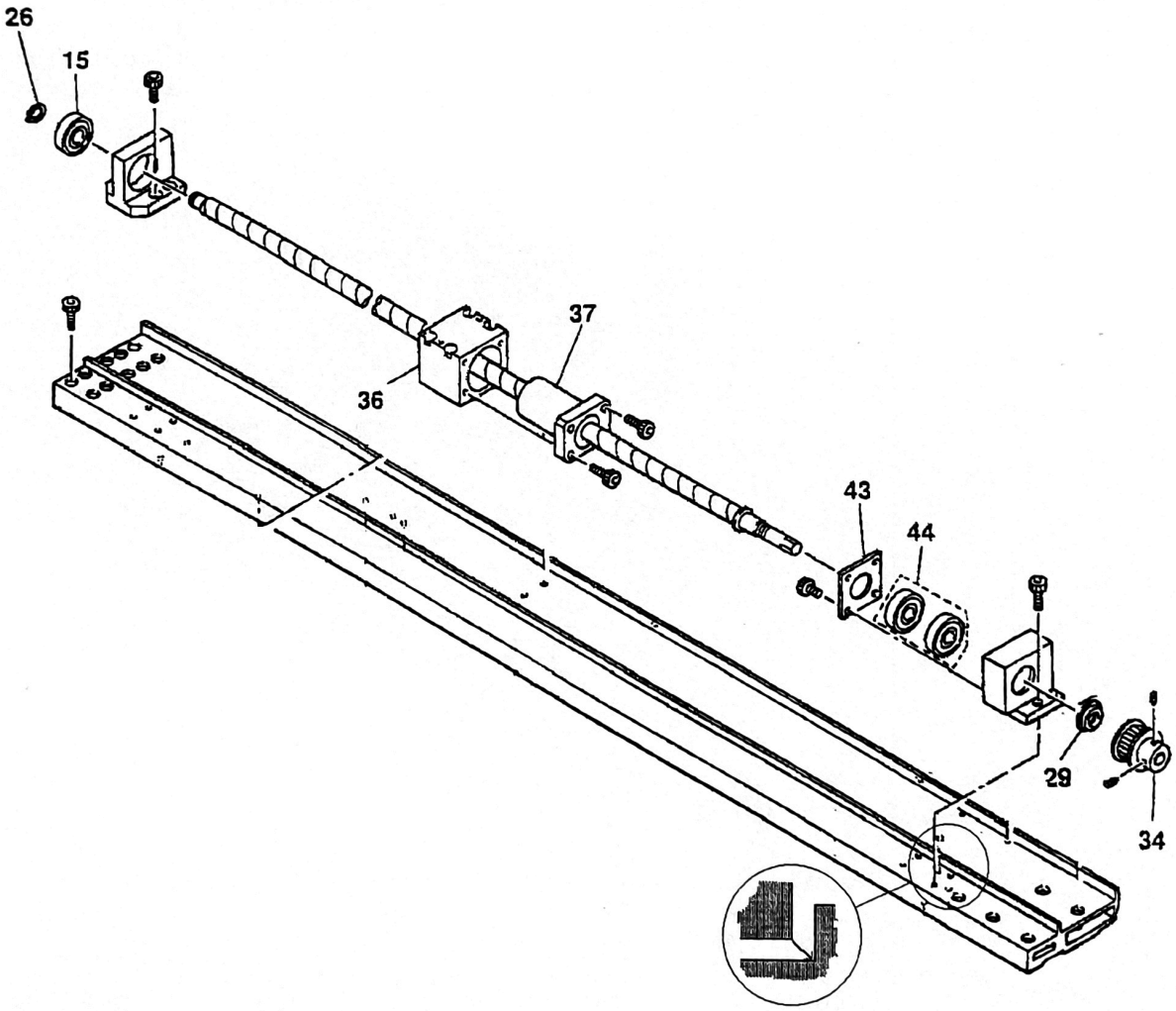


Fig. 7-9
X-Axis Ball Screw attachment.

Step 3. Move the bearings as far as possible to the rear of the system.

Step 4. Tighten the nut at this side of the guide.

Step 5. Move the bearings as far as possible to the front of the system

Step 6. Tighten the nut at this side of the guide.

Step 7. Remove the X-Axis frame + plates from the bearings.

Step 8. Place a straight ruler parallel to the left linear guide and measure the distance by means of a dial gauge. The ruler can be placed on the conveyor rails and is heavy enough to make fixing unnessecary.

Step 9. Move the bearing with the dial gauge to the other end and set the straight ruler to the same distance. At both ends the ruler has the same distance to the linear guide.

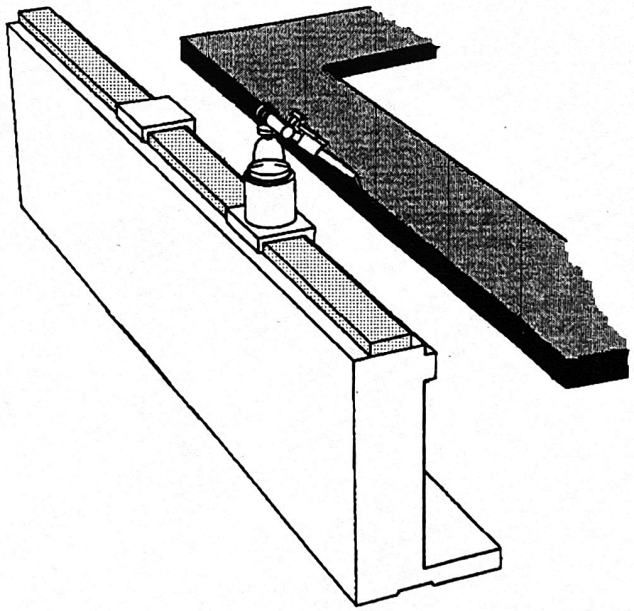
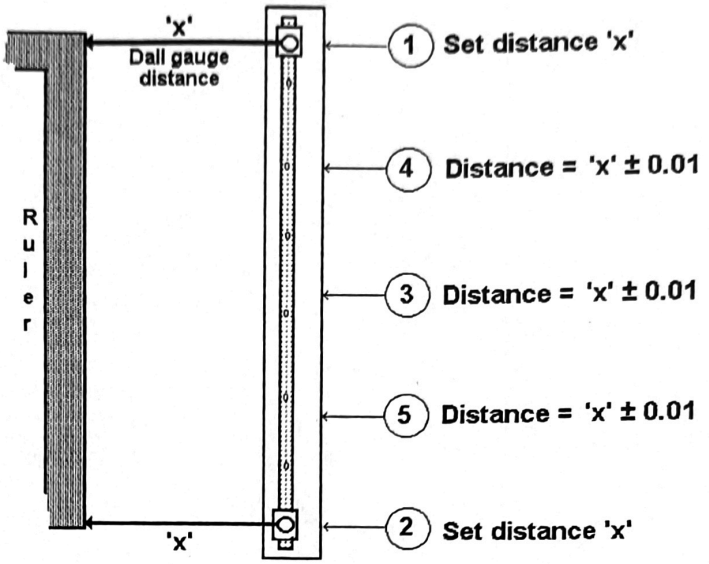


Fig. 7-8
Aligning the left linear guide.

Step 10. Go to the middle of the linear guide and adjust the position of the guide to be within 0.01mm of the measured distances of step 8 and 9. Tighten the nut.

Step 11. While moving the bearing towards the end or front, set the straightness within 0.01mm tolerance and tighten the bolts on the way. See also figure 7-6.

Fig. 7-6
Align method.



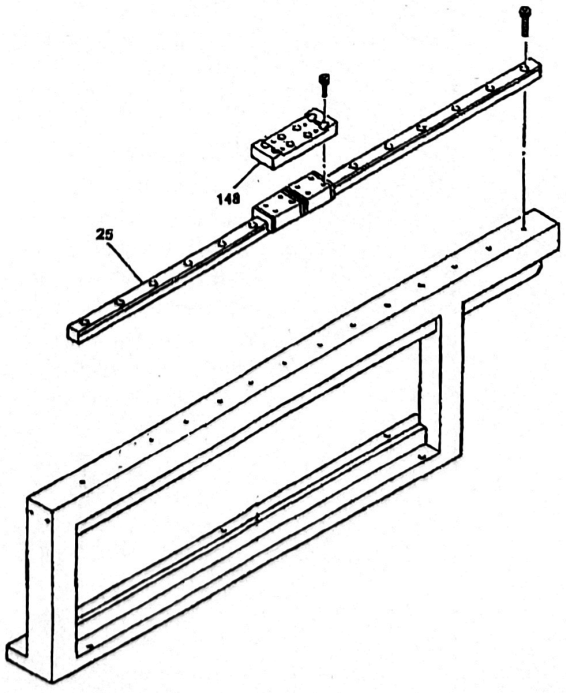
7-3-1-3 Y-Axis: Left linear guide

The left linear guide is marked 'Z1' at the end of the type number marked on the guide itself.

Step 1 Place the left linear guide on the stand. Insert all bolts, but do not tighten.

Step 2. Fix the X-Axis frame + plates to both bearings on both sides.

Fig. 7-7
Left Y Axis Linear Guide attachment.



Step 8. Place a straight ruler parallel to the linear guide and measure the distance via the dial gauge. The ruler can be placed on the conveyor rails and is heavy enough to make fixing unnessecary.

Step 9. Move the bearing with the dial gauge to the other end and set the straight ruler to the same distance. At both ends the ruler has the same distance to the linear guide. Refer to figure 7-12.

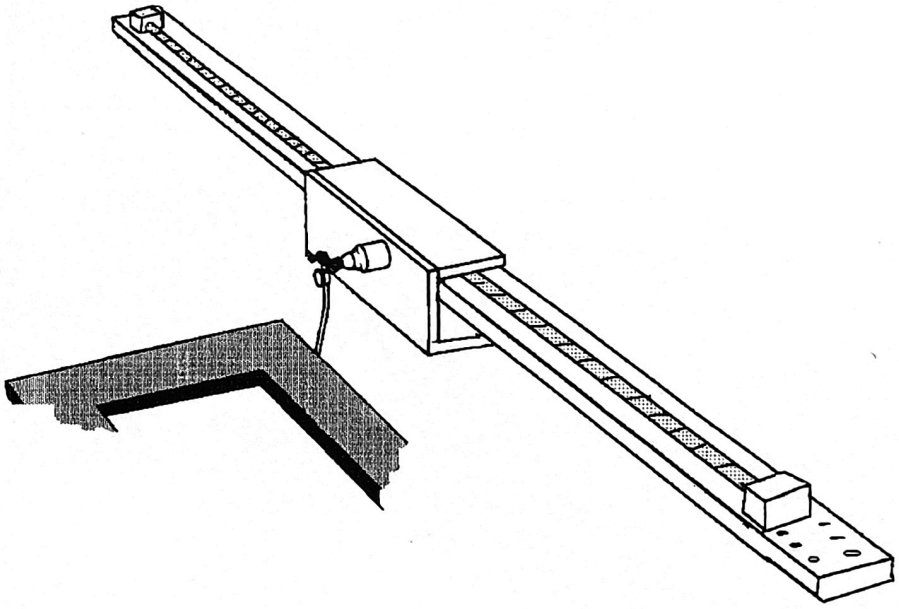


Fig. 7-12
Aligning the X-Axis linear guide.

Step 10. Go to the middle of the linear guide and adjust the position of the guide to be within 0.01mm of the measured distances of step 8 and 9. Tighten the bolt.

Step 11. While moving the bearing towards the end or front, set the straightness within 0.01mm tolerance and tighten the bolts on the way. See also figure 7-12.

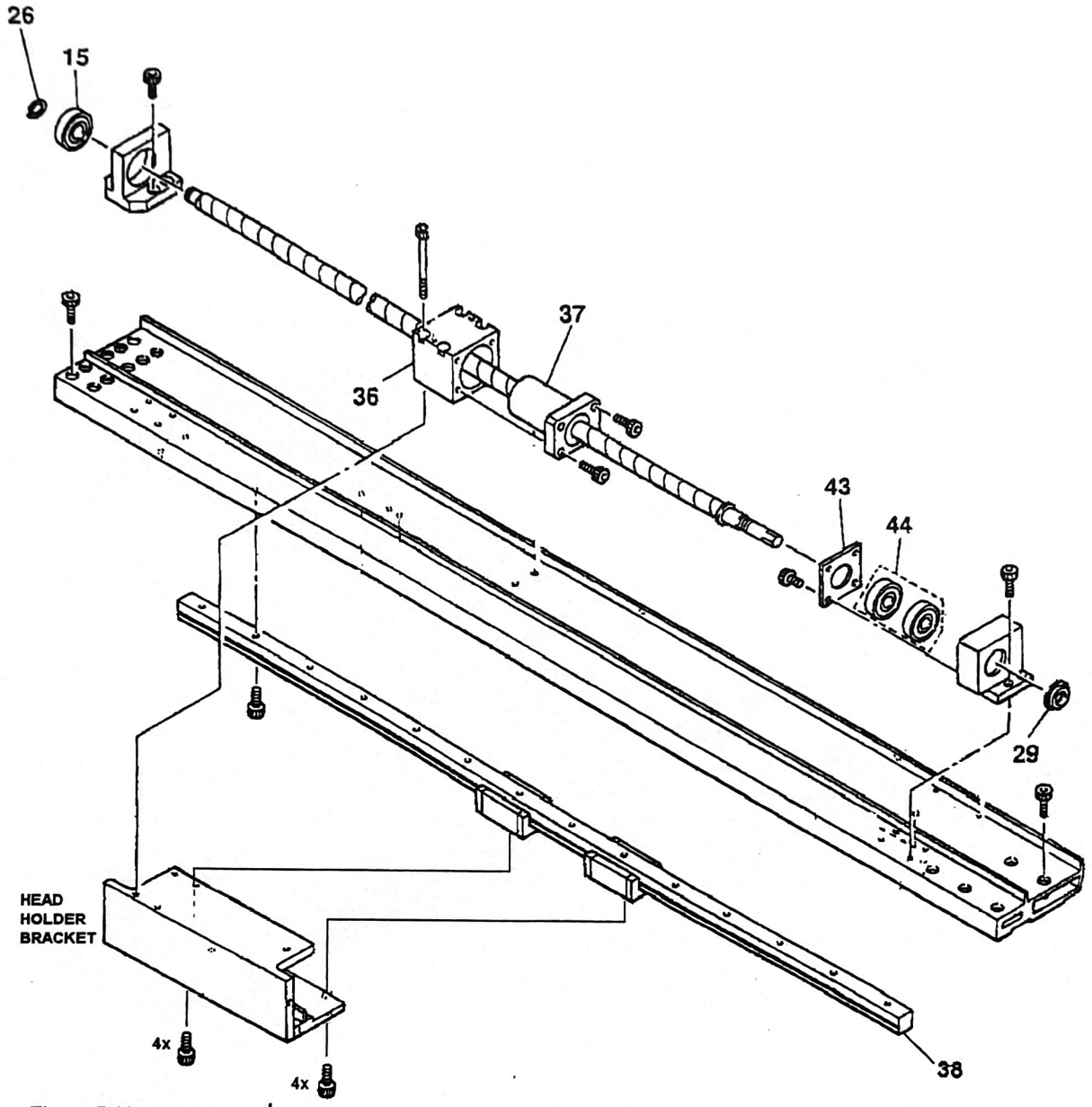


Fig. 7-11 Connecting the X-Axis linear guide bearings to the ball screw bearing.

Step 3.	Move the bearings as far as possible to the left of the system.
Step 4.	Tighten the nut at this side of the guide.
Step 5.	Move the bearings as far as possible to the right of the system
Step 6.	Tighten the nut at this side of the guide.
Step 7.	Remove the plate from the linear guide bearings or disconnect from the ball screw bearing.

7-3-2-2 X-Axis: X-Axis linear guide

The procedure for aligning the linear guide can, principally, be done online or offline.

Step 1. Place the linear guide on the beam. Insert all bolts, but do not tighten.

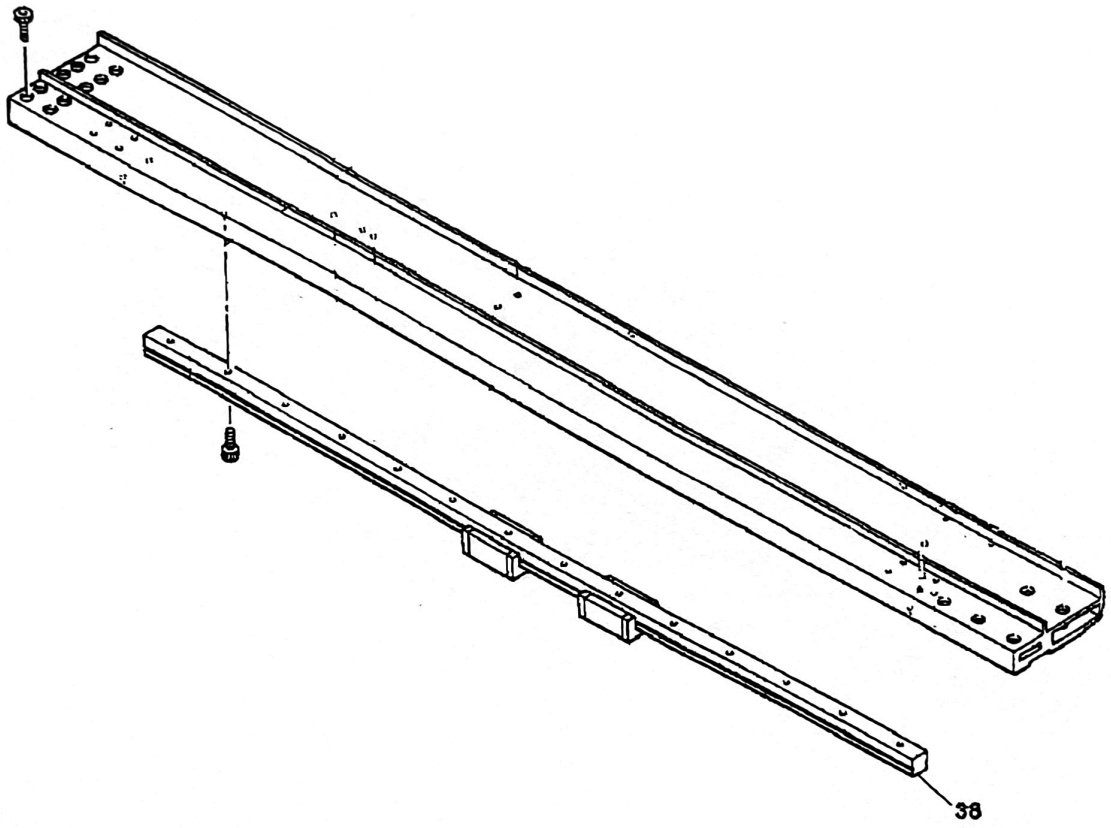


Fig. 7-10 X-Axis linear guide attachment.

Step 2. Connect the plate to the bearings of the ball screw and linear guide. Refer to figure 7-11.

7-4 Occurrences

This section describes what to adjust if one of the situations that are described in section 1.0 occur.

7-4-1 Y-Axis Adjustment

The occurrence that the Y-Axis is not straight is very rare, yet not impossible. When none of the procedures written in all previous sections is the case, and the Y-Axis is analyzed as being the faulty axis, then this requires a complete readjustment of the system. Changing one part of the Y-Axis will very much implicate changing the position of the opposite Y-Axis and therefore affects the positioning of the X-Axis as well.

Nevertheless, if this situation occurs, you will have to re-adjust all axes of the machine again. This adjustment is as described in section 7-3.

7-4-2 X-Axis Frame Dislocated

As mentioned in the introduction, it is most likely that after a crash, the X-Axis frame moved. In this case, the X-Axis frame must be made perpendicular again to the Y-Axis frame. Without stripping the whole system, this can be done by measuring the perpendicularity with the fiducial camera or dial gauge (if no vision system available). The procedure below is written for the camera only. The procedure, when using a dial gauge, is the same.

Alignment is done as follows:

Step 1: Tighten the nuts that hold the X-Axis frame to the Y-Axis linear guides (if they are loose, it is hard to measure where the fault is).

Step 2: Place the ruler on the conveyor on such a location that the camera can follow the straight edge during X and Y movement. Best is to have the X-Axis located all the way to the rear of the system or to the front of the system (rest point).

Step 3: When the situation above is valid, then the movement in Y+ or Y- direction is straight. Set the speed of the system to 10% and move the camera alongside the edge of the ruler in manual mode. Set the ruler straight to this Y movement. See figure 7-15.

Step 4. If the ruler is parallel to one of the Y-Axis linear guides, move the Head of the X-Axis from left to right. Set and tighten the X-Axis beam to the Y-Axis linear guides when the perpendicularity is within 0.03mm. See also figure 7-14.

✎ NOTE ! Once the X-Axis beam is already on the system, this can also be done by means of the camera if available. Different tolerances apply when the whole system is mechanically build up. See section 7-2.

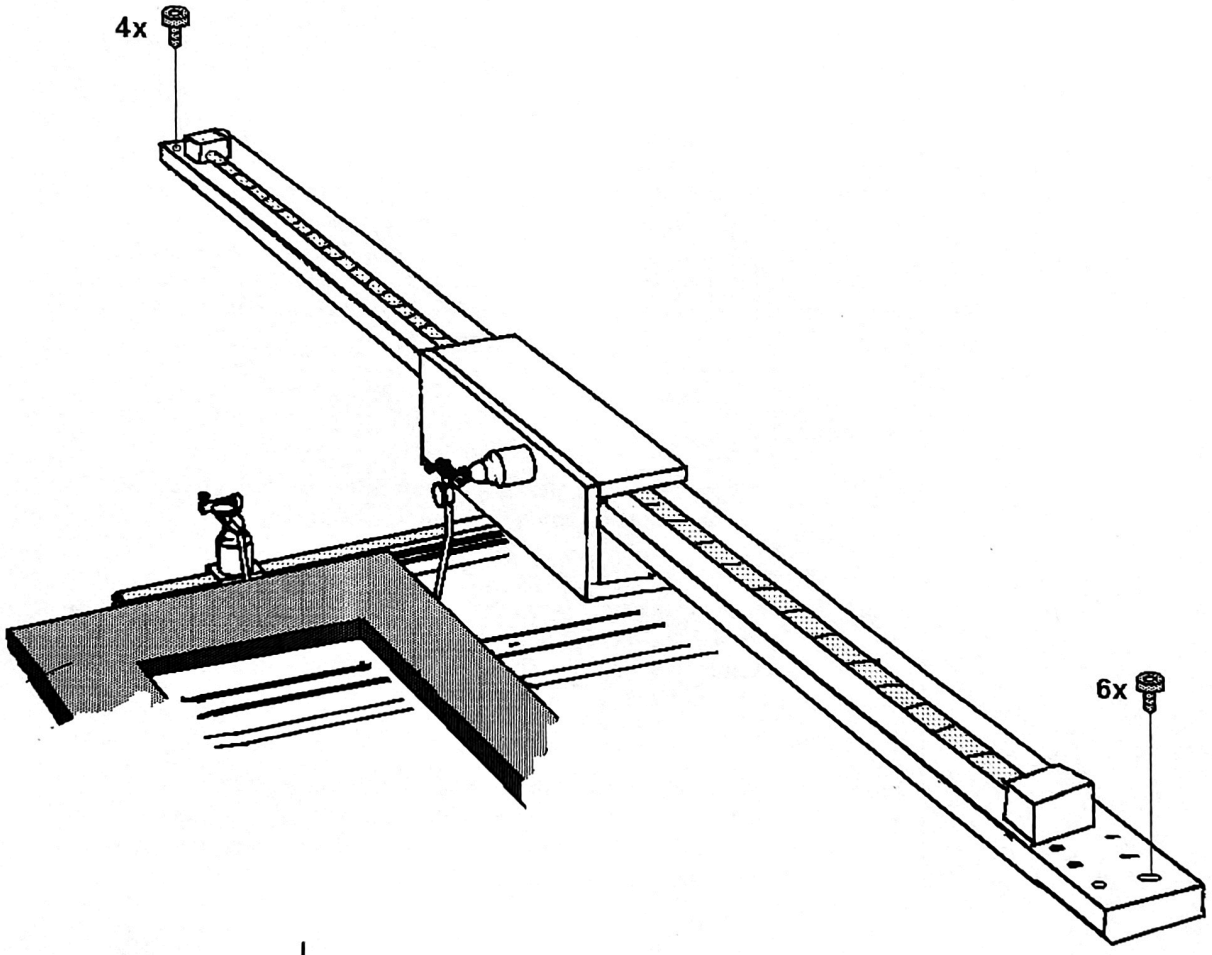


Fig. 7-14
Setting the axes perpendicular.

7-3-3 Perpendicularity

Now, the X-Axis linear guide is straight, so are both Y-Axis linear guides. However, the perpendicularity has not been adjusted yet.

Step 1. Place the ruler parallel to the right or left linear guide. Both the X and Y side of the ruler must be accessible. Setting the ruler parallel to the guide is described in previous sections

Step 2. Place the aligned X-Axis beam on the plates of the Y-Axis linear guides (if not done already). See figure 7-13.

Step 3. Insert the 10 bolts that hold the X-Axis beam to the linear guids, but do not tighten (hand tight only).

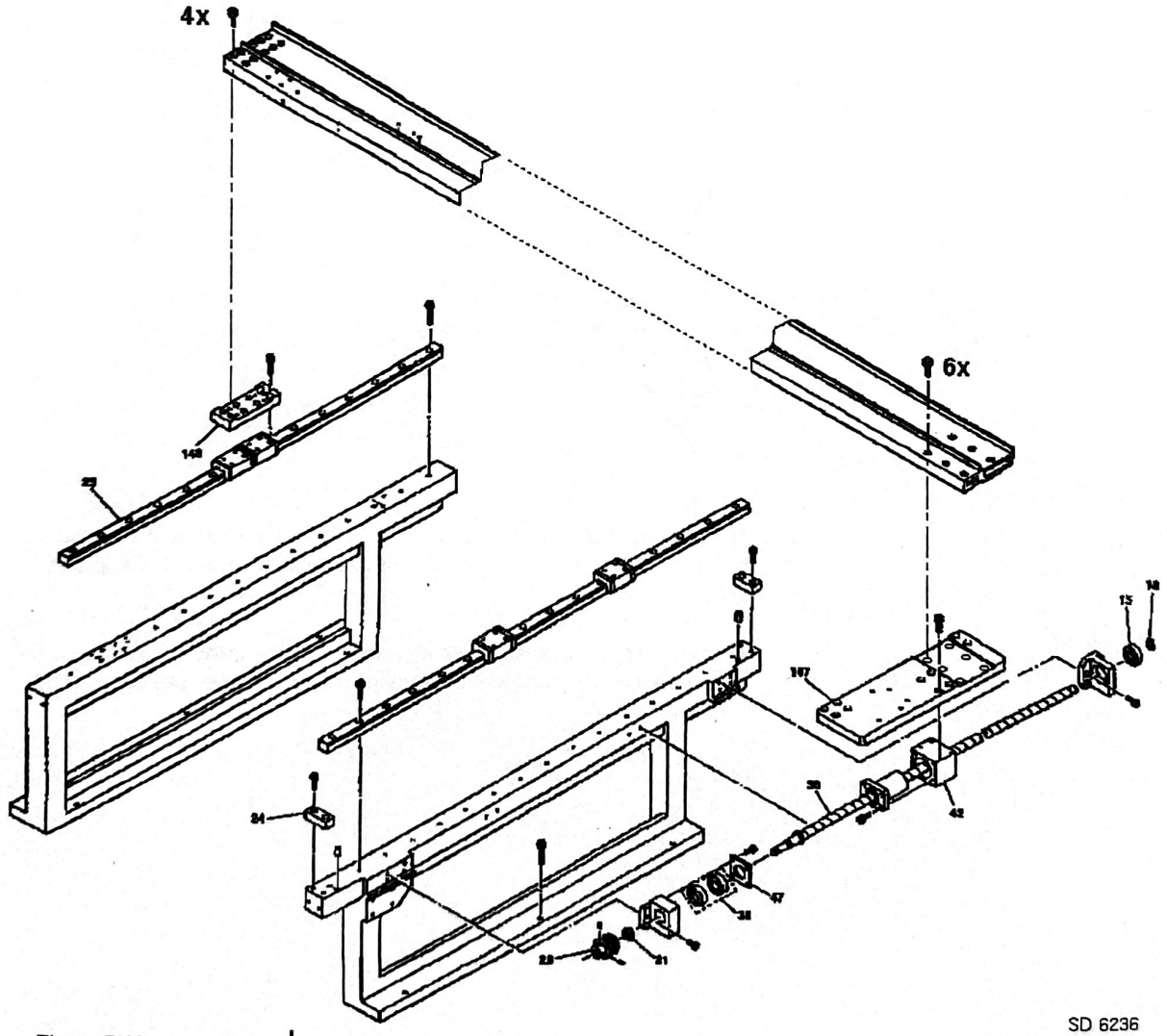


Fig. 7-13
Adding the X-Axis beam.

7-4-3-2 X-Axis linear guide shows a dip

This can occur after a head crash has taken place. The following can be possible:

1. Some bolts loosened
2. Guide has shifted (e.g. bolts were not tight enough)
3. Guide bent (dip)

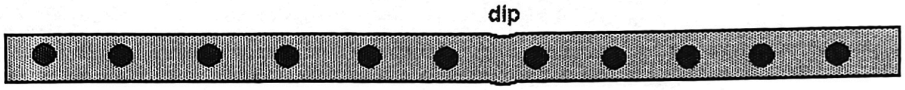


Fig. 7-17 Dip in X-Axis linear guide.

In case of situation 3, the guide must be replaced. Refer to section 7-4-1.

In case of situation 1 and 2 perform the following step:

Step 1: Disconnect the cabling from the CON2 (item P22) PCB and remove the screws holding this PCB. This will give better access to the bolts on the Motor side.

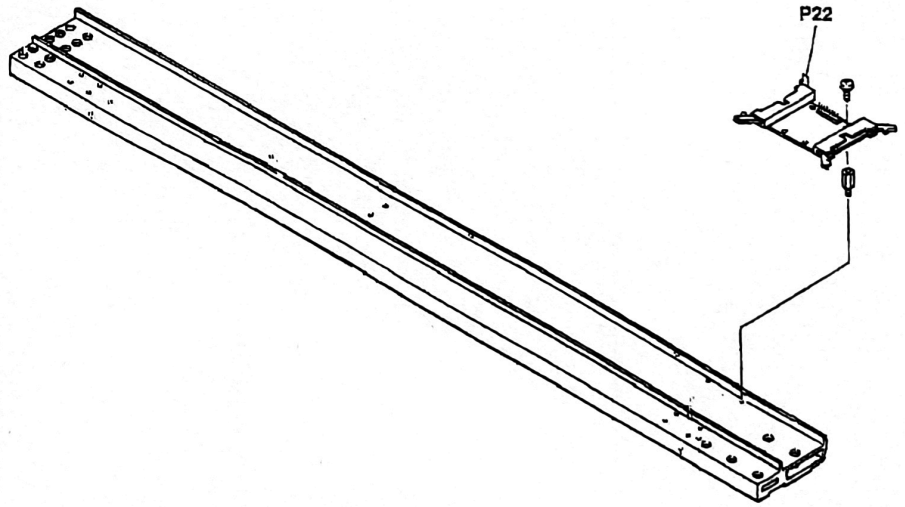


Fig. 7-18 X-Axis: Removing the CON2 PCB.

Step 2: Check first if the bolts are really fixed well. Move the X-Axis all the way to one corner and fix all bolts really well. Move the head to the other side and fix the last couple of bolts as well. Check now (with the ruler of step 2.) if the X-Axis still shows the bent location. If it does, continue with step 3, else, the guide is straight and the procedure can be stopped.

7-4-3 X-Axis Linear Guide not Straight

X-Axis linear guide replacement is necessary in the following case:

- Offset placements in a certain area only (on a PCB)
- If the X-Axis, during measuring, shows a curved movement or shows a dip.
- A third possible cause, and showing sometimes the symptoms of above, is that the retaining screws of the linear X-Axis guide are not tight anymore. In this case they must be tightened again.

7-4-3-1 X-Axis Linear Guide Replacement

In case the X-Axis linear guide shows either of the two symptoms mentioned above, then, depending on how bad the symptom is, the X-Axis linear guide must be replaced or straightened.

Step 1: Remove the 8 bolts that hold the bearings to the head holder bracket.

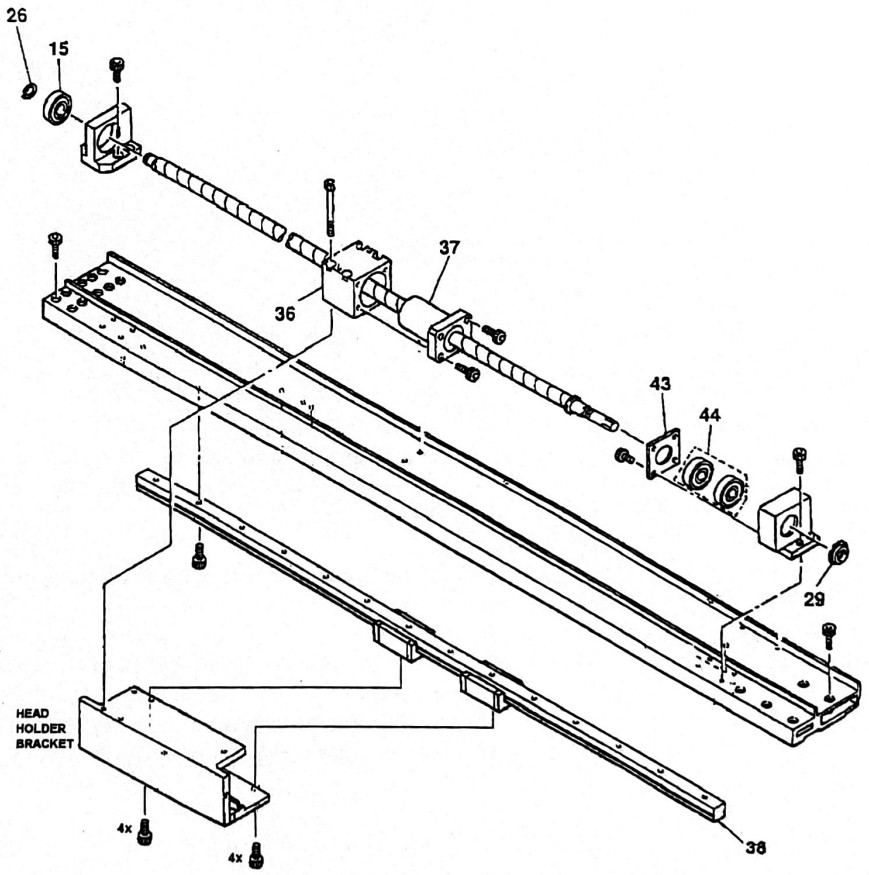


Fig. 7-16 X-Axis linear guide replacement.

Step 2: Remove all bolts that hold the linear guide to the X-Axis frame.

Step 3: Adjust as described in section 7-3-2.

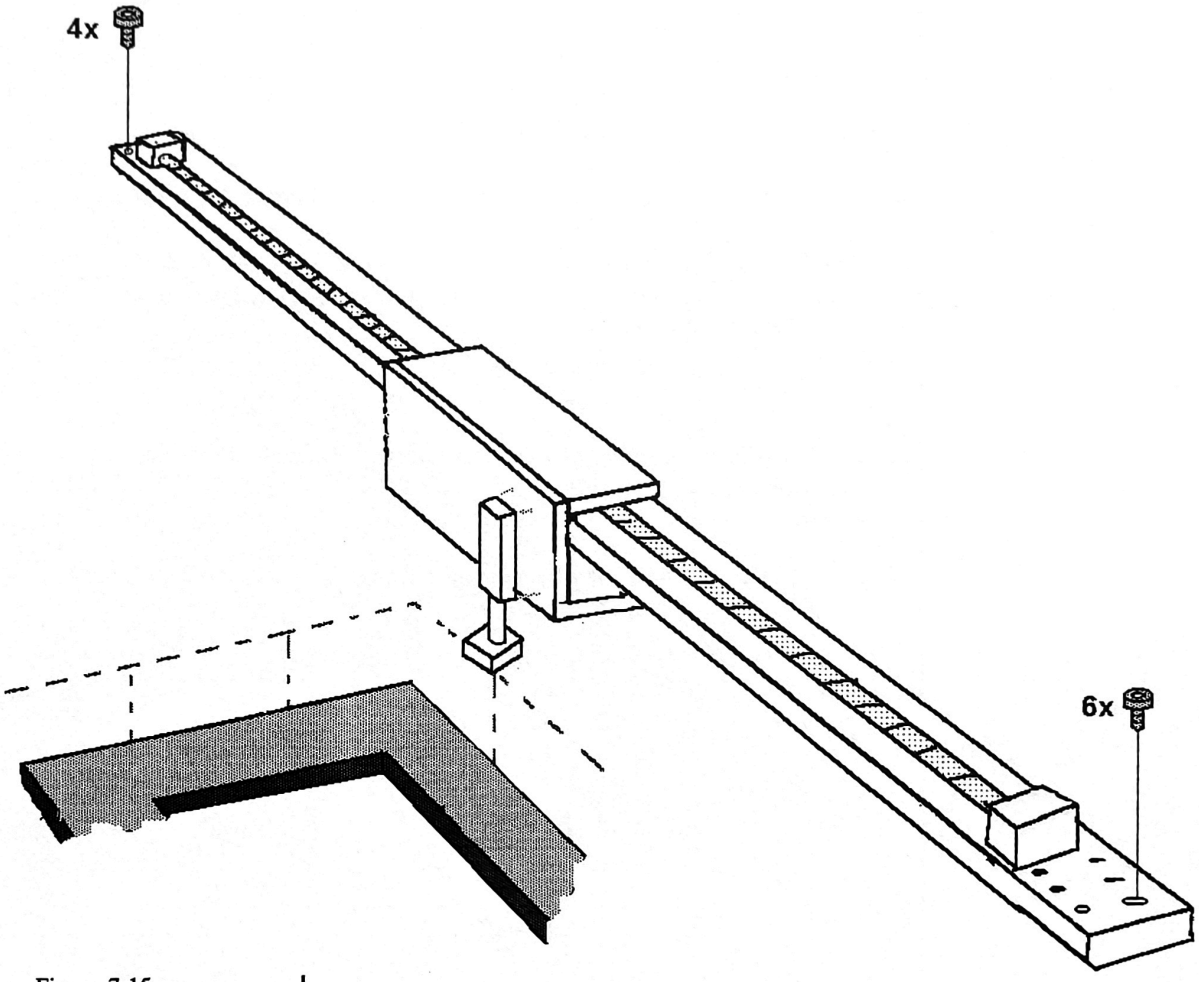


Fig. 7-15
Aligning the X-Axis frame.

Step 4: Use table 2.0. for tolerances. If the ruler is located straight in Y direction, then measure the (perpendicular) straightness of the X-Axis during X+ or X- movement.

Step 5: If the X-Axis frame is not within the specified tolerances, then loosen the bolts

Step 6: Shift the X-Axis in the direction of correction. Slowly move the X-Axis and check with the camera if the Axis is perpendicular to the Y-Axis (within tolerances). A tie-wrap can be put tightly over the Y-Axis motor belt in order to prevent the Y-Axis from moving during X-Axis correction.

Step 7: If step 6 was successful; tighten bolts firmly. Adjustments are finished.

7-5 Adjustment Tools

A number of adjustment tools are listed below in order to align the axes.

Tool Nr.	Name	Order Code	Used for
1	Magnetic Stand	5322 395 90885	To hold feeler dial gauge
2	Dial Gauge	5322 349 20122	Gauge to measure the linearity of the axes system
3	Adjusting jig X/Y	5322 395 80373	A jig to calibrate the different servo axes.

Tool Specifications:

Magnetic Stand: Disengageable permanent Magnetic stand with flexible arm and fine adjustment. Foot l x w x h = 60 x 45 x 50mm. Flexible arm length 300mm for dail gauge spindle ¢8.

Dial Gauge: Käfer dail gauge. Range 3mm, resolution 0.002mm. Fitting 8h6.

Adjustment Jig (Square): High accuracy (2 sides only) square angle with knife edge. Dimensions 365 mm x 495 mm x 15 mm. Use by placing the jig on the conveyor rail after having the pcb clamping plates removed (for flat surface). Because of the weight of the ruler, fixing is not nessecary.

Step 3: Place a ruler on the conveyor parallel to the Y-Axis

Step 4: Check with camera or dial gauge where the curve or dip is noticeable.

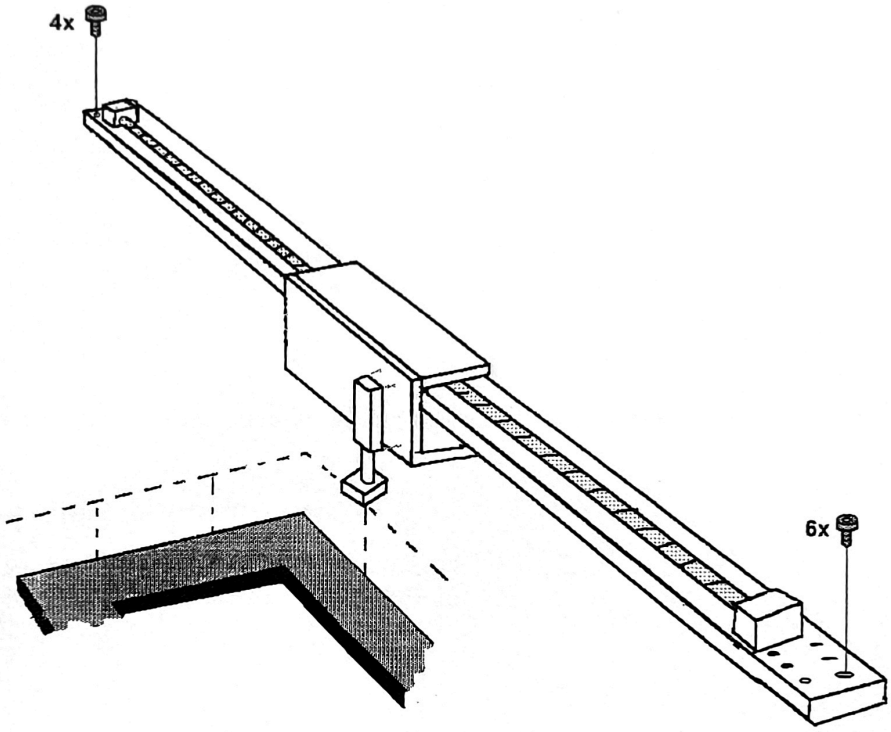


Fig. 7-18 Aligning the X-Axis linear guide.

Step 5: Fix the bolts of the linear bearing hand-tight at this location.

Step 6: Hit the linear guide carefully with a hammer (that has a hard plastic top) in order to straighten it.