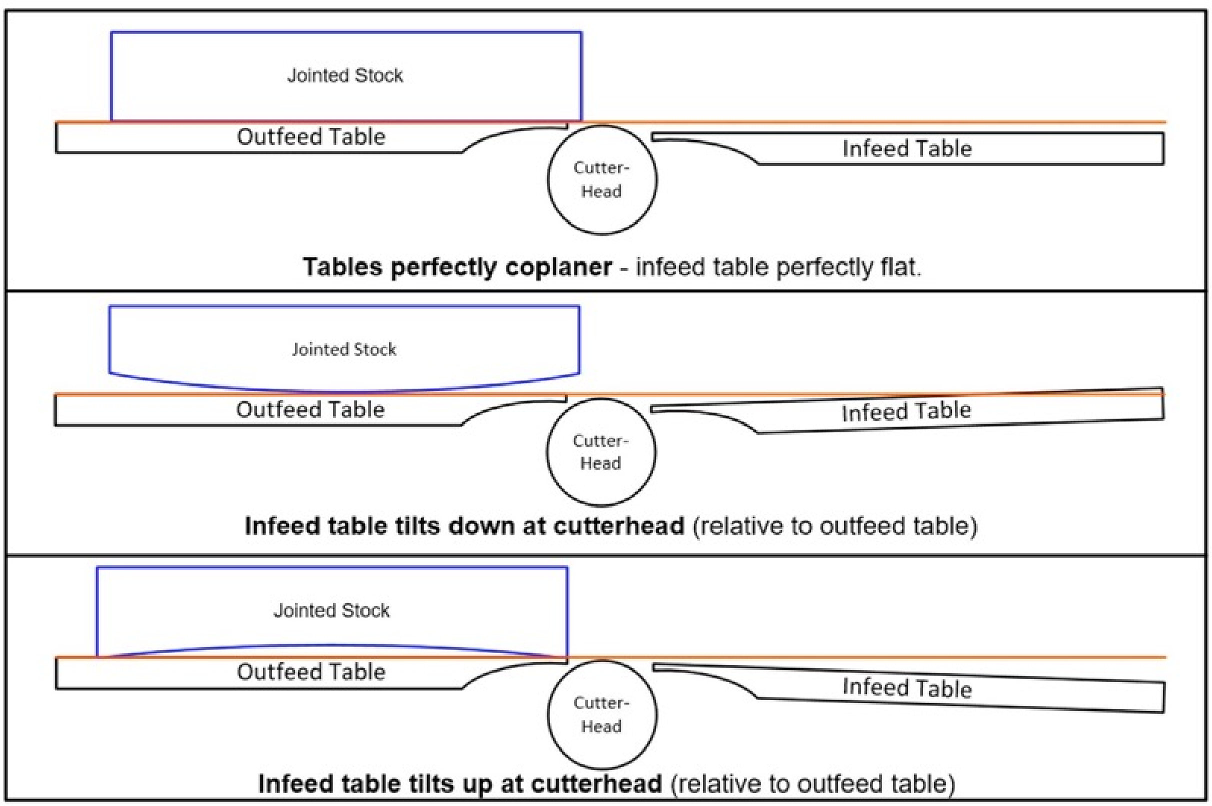
Felder 20-inch Jointer Table Design Analysis

by David P. Best

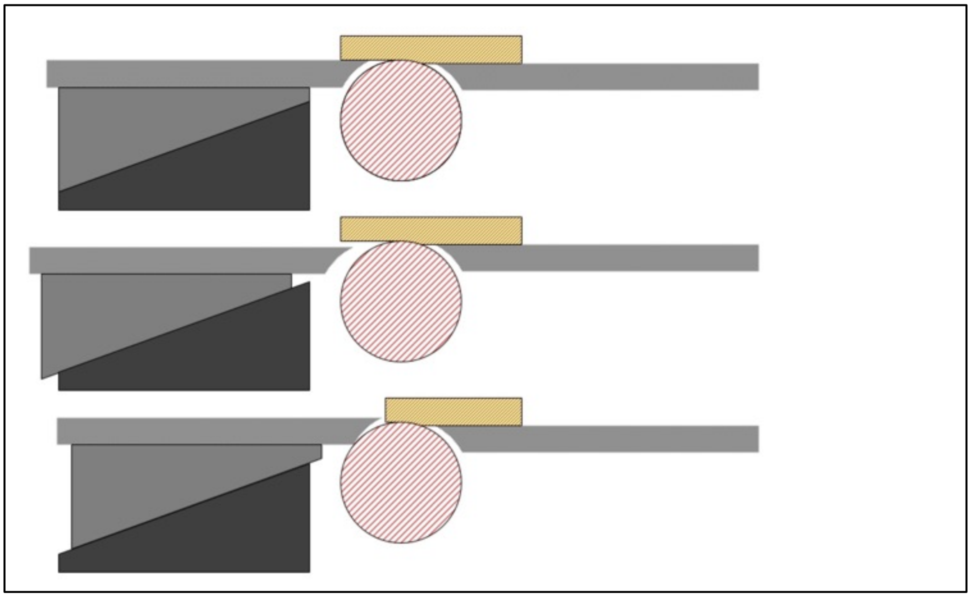
Although technical, the analysis that follows attempts to explain some of the deficiencies with Felder 20-inch (510mm) jointer/planer combination machines (AD951 and Dual 51 specifically). I have consistently recommended to potential users that if they need a machine with a 20-inch-wide capacity, they evaluate and consider alternatives to these particular models.

First, consider whether 20-inch capacity is a necessity – in my opinion, Felder offers more trouble-free jointer/planer machines in the 16" and smaller capacities. Or give more serious consideration to separate jointer and planer machines – such as the Felder Plan 51L or A 951L jointer in conjunction with any of the Felder stand-alone planers. And evaluate alternatives from other manufacturers.

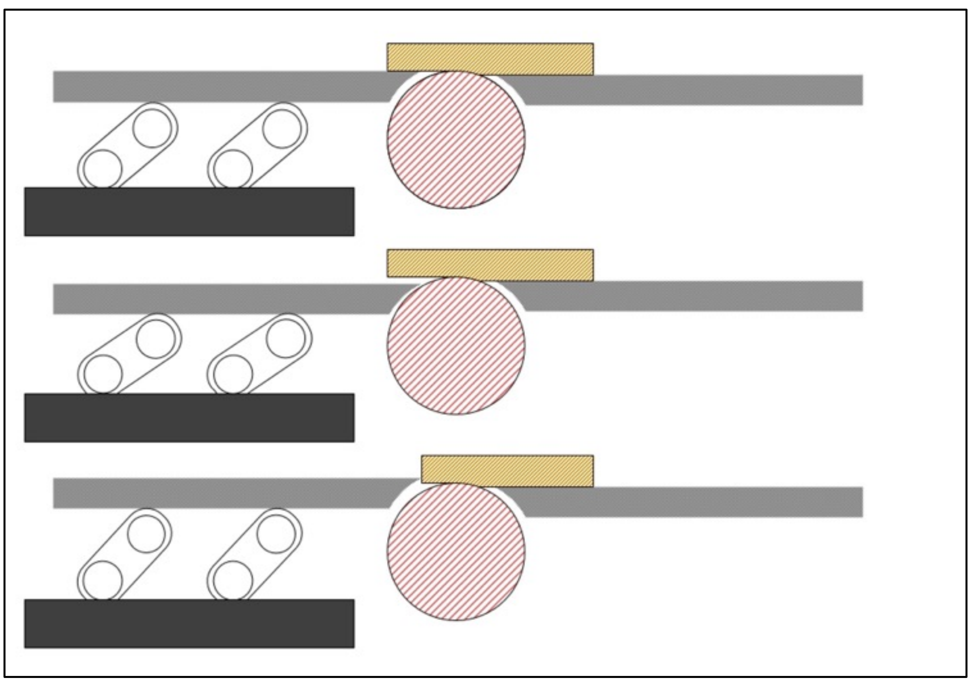
Most of the issues with these 20-inch jointer/planer machines from Felder center around the flip-up jointer tables. The problems here all relate to the need to keep the infeed and outfeed tables coplanar even though they are at differing heights and move independently from each other. Below is an illustration of what happens when the two tables are <u>not</u> coplanar to each other:



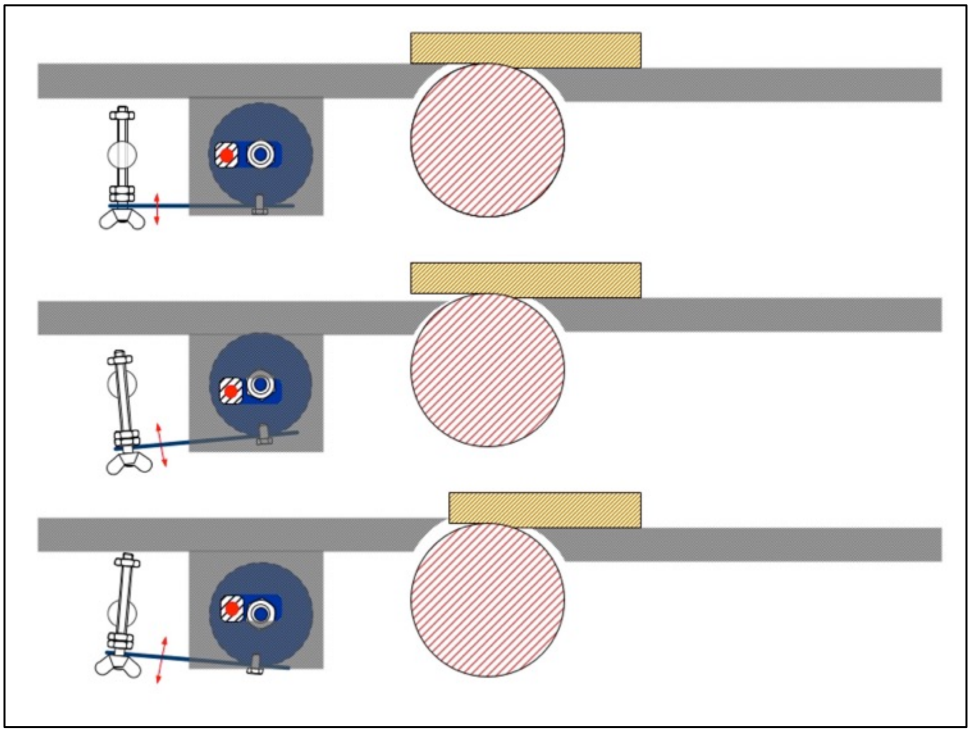
First, some background about jointer table designs. Older style jointers were designed with inclined wedge-shaped machine surfaces that moved the surface of the table up and down. A screw mechanism typically pushed/pulled on a wedge to move the tables up/down. Since the wedge components are precision fit, with dovetails and guides, the table remained level in both directions as it was moved up/down:



More recent designs employ a parallelogram system that elevates the tables. When properly designed and sized to the mass of the tables, this system does an excellent job of keeping the tables aligned as they move up/down. The parallelogram-type system operates as illustrated below and is used in some of the smaller Hammer machines and those made by Martin and SCMI, among others:



Beginning around 2004, Felder began to migrate their jointer designs away from the parallelogram system as they moved to a new mechanism for controlling table height in their mid-range models (731 and 741). This system is described as having "prism guides" in their literature and on their website. It replaces the previous parallelogram system with prism-shaped guideways and a large cylinder that rotates via a handle to move the tables up and down. The cylinder features two eccentric cam lobes at either end, which move the tables up and down along prism-shaped guideways. The infeed table's prism guides are sloped, while the outfeed table's prism guides are vertical. While it can be somewhat challenging to explain, the new design significantly differs from the other designs as shown below:



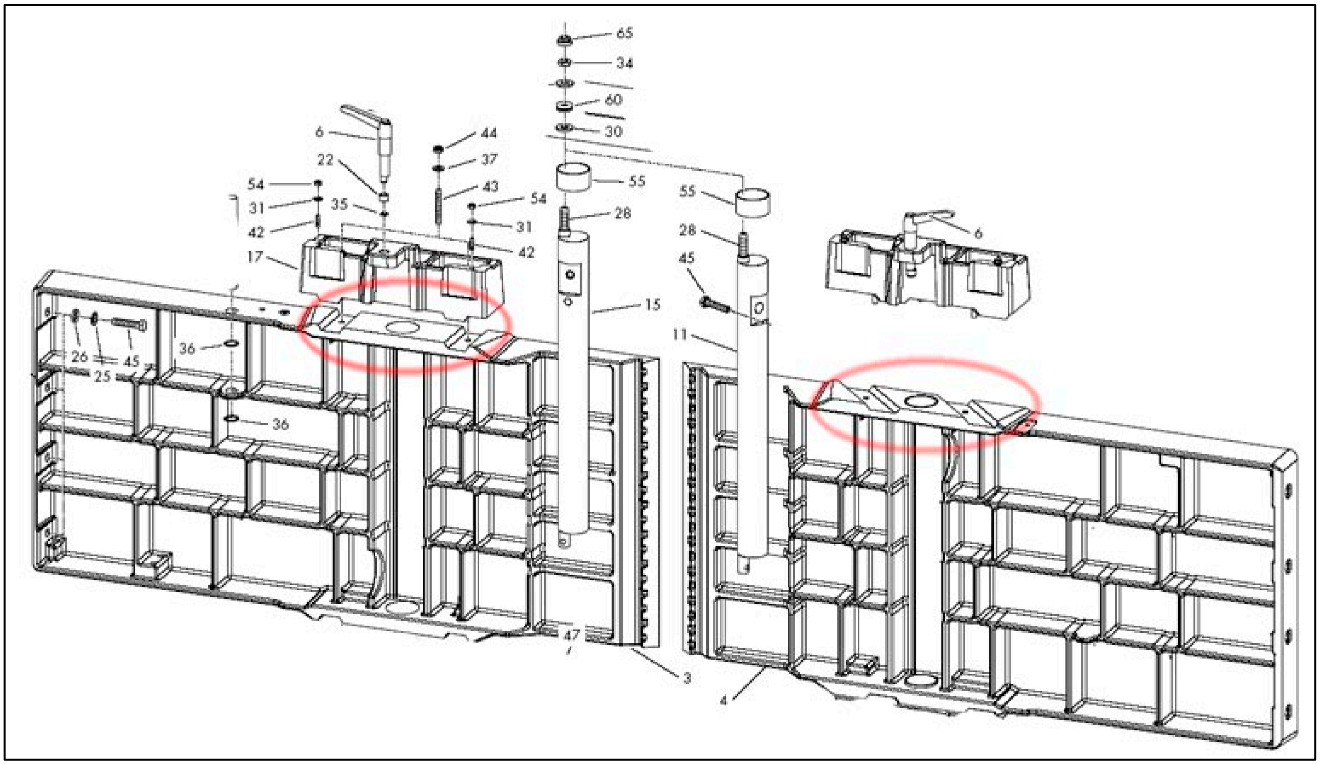
Felder moved to this new system, presumably, to simplify the manufacturing process and lower costs (the parallelogram system requires more precise manufacturing to function accurately). This cam-based "prism guide" system seems to perform well on Felder's mid-range jointer/planers up to about 16" capacity (AD731, AD741, AD941).

However, with the increased table mass of models like the Dual 51 or AD951, and the addition of a hinge mechanism for flipping the tables up and down, the elevation system and the hinge supporting the tables have proven to be undersized, leading to alignment difficulties. The jointer tables on the Dual 51 and AD951 are challenging to adjust and align properly. Over time, they often go out of alignment, resulting in non-flat jointed surfaces. Furthermore, Felder sets up their jointers to produce a concave or a "spring joint" when they leave the factory, operating on the assumption that the jointed surfaces will primarily be used in edge-to-edge glue-ups. Therefore, these tables must be realigned after delivery to achieve flat results – a tedious task, often beyond the skills of a typical woodworker.

There have been several instances where Dual 51 machines were shipped to customers with this delicate cam elevation system damaged in transit, necessitating a complete machine replacement. These situations have led to frustration and blame-shifting, prolonging the wait for a new machine by several months.

Design Analysis

The following section provides technical detail and analysis of this table elevation system. The drawing below illustrates the basics of the infeed and outfeed table support and elevation system on the AD951 and Dual 51 jointer/planer. The smaller Felder combination jointer/planer machines are based on this same system – in fact, this system originated on the 12" wide AD731 model and subsequently evolved into the larger capacity jointers.

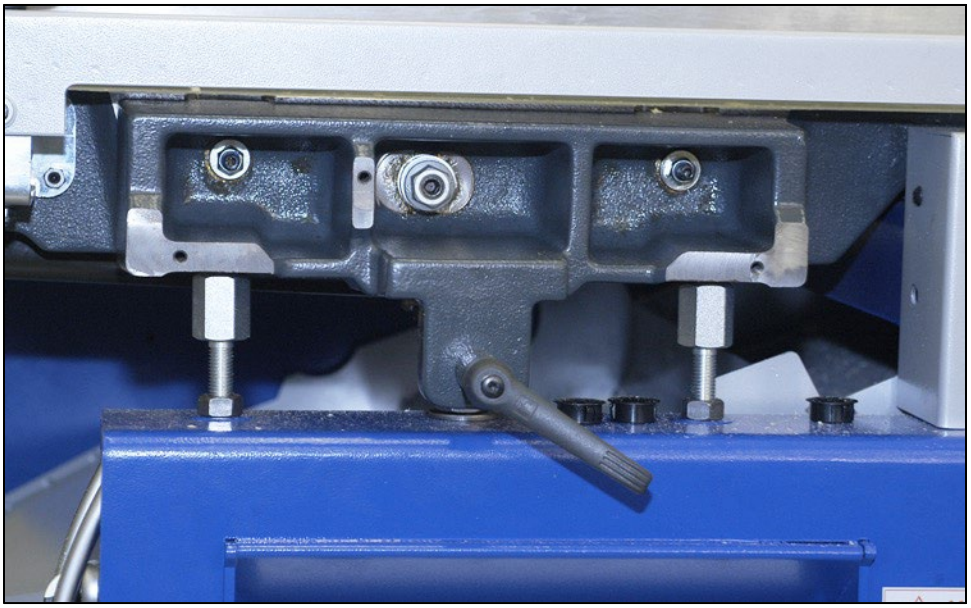


Take note of the two components circled in red. These are the prism-shaped guideways (referred to as "prism guides") that are machined into each side of the tables. The infeed table features prism guideways that are sloped, while the outfeed table has prism guideways that are oriented vertically (straight up and down).

Above the parts marked in red on the drawing, there are castings that have been machined to fit the prism-shaped guideways on the tables. For the sake of clarity, we will refer to these as "elevation blocks." These blocks are present on both sides of each table.

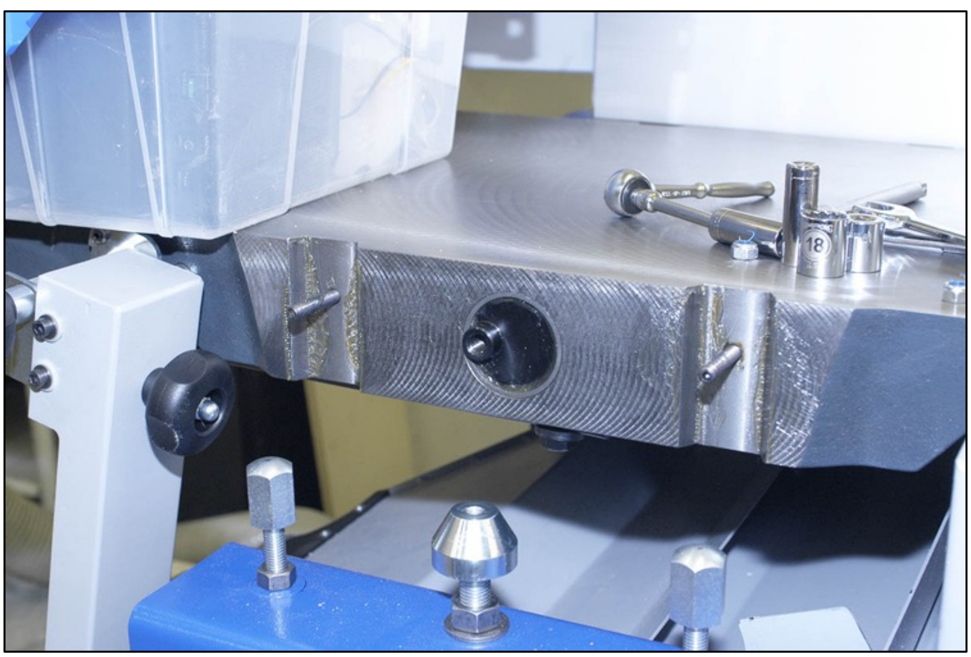
On the hinge side of the tables, the elevation blocks are bolted to the hinge mechanism, which allows the table to rotate upward and backward into a vertical position. On the front side of the machine, commonly known as the "latch" side, the elevation blocks rest on adjustable temple bolts that form part of the latching mechanism. This mechanism secures the tables to the machine base when the tables are lowered into the jointer position.

The following photograph shows the outfeed table of a Dual 51 with the covers removed. It displays the elevation block secured to the edge of the outfeed table casting and latched down to the temple bolts using the black-handled Kipp lever. The height difference between the two temple bolts determines the alignment of the table on the latch side of the machine. When the Kipp lever is operated and locked, it forces the latch side of the table down against the temple bolts, ensuring proper alignment (assuming the temple bolts are adjusted properly). Thus, the relative height of the two temple bolts establishes the angle of the table on the latch side, while the hinge side is aligned using a different mechanism.



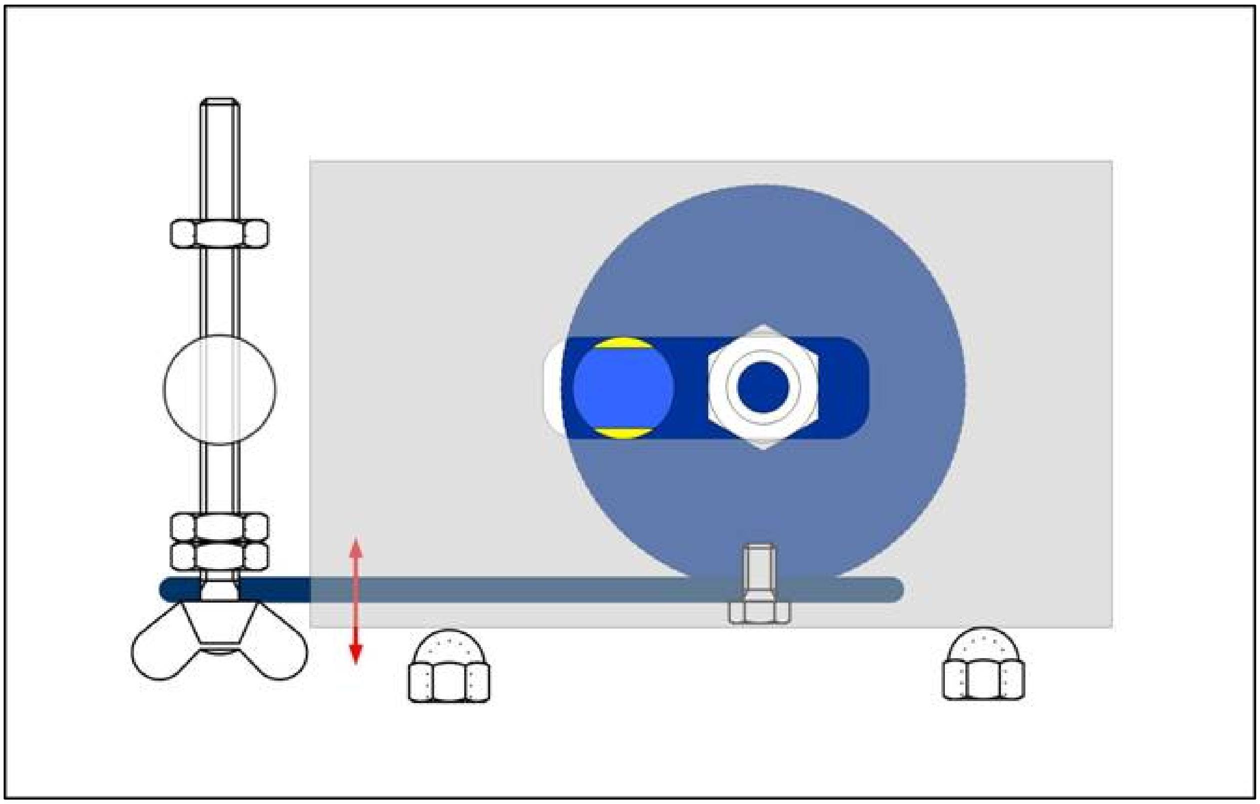
The elevation block is secured to the side of the table casting using three fasteners, which are visible above as three hex-head fasteners in the recesses of the elevation block casting. The hex-head fastener located at the center is a bolt that connects to an elevation shaft which rotates to raise and lower the table using eccentric cam lobes. The other two hex-head fasteners are nuts that help secure the elevation block to the table via threaded studs.

Below is a photo of the same outfeed table with the elevation block removed exposing the two prism-shaped guideways, as well as the lobes on the eccentric cam shaft and the threaded studs.



The table is forced to align with the elevation blocks via the prism-shaped guideways on each component. Threaded studs, located within these guideways, bring the two components into contact and secure the elevation blocks to the table. The entire weight of the table is supported by these connections to the elevation blocks. The elevation blocks, in turn, are attached to the machine chassis via temple bolts on the latch side, and through a hinge mechanism on the opposite (hinge) side. The table’s height is adjusted by moving a lever that rotates the central shaft which has the eccentric cam elements extending from it. As the shaft turns, the cam element moves up/down inside a corresponding slot in the elevation block, raising or lowering it as needed.

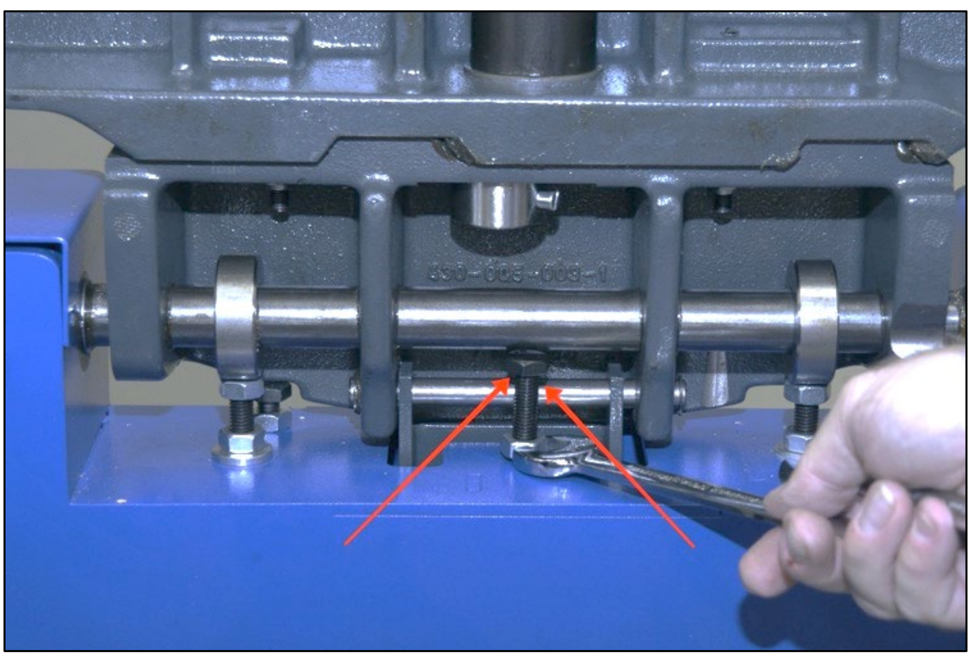
The following drawing illustrates this action – The light grey area is the elevation-block. As the shaft is turned, the eccentric cam element is rotated up or down, and in turn drives the elevation-block the opposite direction as the cam element pushes up/down and slides sideways in the slot in the elevation-block due to the twisting action.



The same action occurs on the opposite side of the table – the shaft includes a matching eccentric cam element that fits into the same slot geometry on the elevation block attached to the hinge mechanism.

My reservations about this system are summarized below:

- This system is a departure from conventional jointer table designs that elevate the table. Older style jointers prior to the 1970s had tables that were designed using an inclined plane (typically on dovetail guide ways) to raise and lower the tables while supporting the weight of the table across a broad platform, or a system with parallelogram-type structures that also provide broad support of the tables moving up/down.
- While this cam-type elevation system isn't bad or wrong simply because it's different from convention, it does have inherent weaknesses compared to a conventional design unless it is considerably larger in scale and made of very robust materials such as hardened steel.
- Considering the significant weight of the table supported by these elevation blocks, a wider elevation block would be more effective in balancing the cantilevered weight. In my opinion, this system is undersized for the massive table weights on a Dual 51 or AD951.
  Moreover, Felder has implemented a jack-screw system on the hinge side to prevent the hinge pin from flexing and distorting due to the increased weight of the tables. The smaller AD741 and AD941 models have a simplified and more robust hinge design that is easier to adjust for table alignments and eliminates the need for this supporting jack screw. The initial production runs of the Dual 51 lacked this jack screw which led to table alignment instabilities. Instead of upsizing the hinge pin mechanism to a more robust structure, Felder opted to add the jack screw as a workaround for the design deficiency in this hinge mechanism. As of the date of this publication, this jack screw and undersized hinge shaft remain as part of the hinge mechanism. The hinge shaft and the jack screw that was added to the design can be seen in the following photo:



- Unlike the infeed table elevation system, which moves the table up and down along an inclined plane, the outfeed table is driven straight up and down. The required vertical movement creates stiction issues between the mating prism guides making it difficult to force the outfeed table to move up or down. It also creates the potential for alignment errors, as the critical alignment from one side of the table to the other relies entirely on this small cam element and how precisely it fits within the slots of the elevation blocks. Additionally, all these components are made from carbon steel that is not hardened or precision-ground.

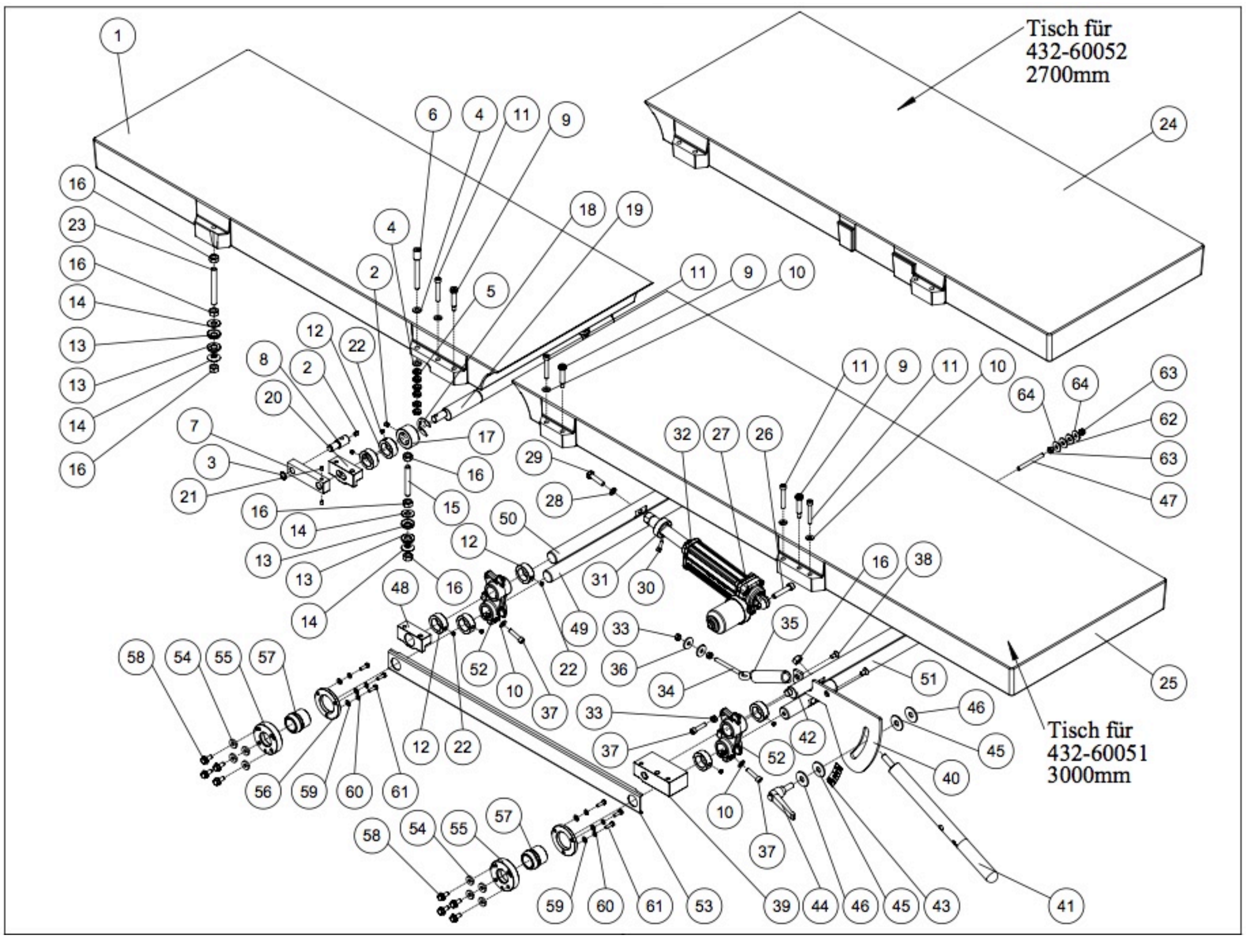
- On other industrial equipment of this size, where substantial weight is being suspended in a cantilevered manner and movable in an up/down direction (the knee table on a milling machine as an example), the guideways that support the system would be a captive dovetail configuration that distributes the weight over the length of the guide-ways and dovetails, with a separate screw-driven mechanism used to alter elevation.

It is important to note that the elevation-blocks themselves determine the angle of the outfeed table relative to the infeed table. The same is true in reverse on the infeed table. To change that orientation and bring the two tables into a coplanar alignment, the elevation-block-to-machine chassis interface must be altered. On the latch side, this is relatively simple and is done by changing the relative heights of the temple bolts on which the elevation-blocks rest when latched. On the hinge side of the machine, this is done by raising/lowering and changing the angle of the hinge pivot shaft – a tiresome and very fussy job on the Dual 51 and AD951.

Felder A 951L and Plan-51L stand alone jointers – some key differences worth noting

The Felder A 951L and Plan-51L are the only stand-alone jointers made by Felder that do not have flip-up tables. The smaller jointer-only machines from Felder are all de-featured versions of a combination jointer/planer machine, and as such have flip-up tables and all the shortcomings that come with them. Looking at page 3 in the exploded parts diagrams for the A 951L and Plan 51L, it is obvious that Felder has moved to a durative of the parallelogram table elevation system for the infeed tables of those machines.

Shown below is the parts explosion diagram for the Plan-51L – the AD-951 is similar in design but eliminates the mechanism that provides for continuous tilt alteration by the user. Note that the outfeed tables of these two machines retain the eccentric cam elevation system noted in the previous section. Since the tables do not flip up/down and with the improved infeed table support/elevation systems, these machines are less prone to table alignment issues than the smaller jointers and jointer/planers offered by Felder.



This is my analysis. The infeed table is supported by a parallelogram system - parts 51 and 49 are the two lower bars, and 42 and 50 are the upper bars, with parts 52 acting as the parallelogram coupling system between the upper and lower bars. Table elevation is actuated by a server motor (32) push/pulling against the upper parallelogram arm closest to the cutterhead (50). The servo system used here appears to be very similar to the servos used on the other Format-4 machines for trunion tilting. Infeed table tilt (from convex to concave cutting) is accomplished via an eccentric cam element on the ends of the upper parallelogram bar furthest from the cutterhead (42). A lever (41) rotates the bar (42) causing the cam on the end of that bar to raise or lower the end of the table furthest from the cutterhead. I cannot tell from this drawing the size (and thus robustness) of these components. The infeed table parallelogram system appears to be mounted to the machine chassis via blocks (48 and 39) with vertical alignment adjustments that are part of the mounting, but there isn't enough detail for me to be absolutely sure.

What is clear is that this table does NOT share the sloped prism guide way system found on the infeed table of the Dual 51 and other Felder jointers with flip-up tables, and the design is a throwback to earlier designs employing parallelogram elevation systems. Once adjusted and left stationary (not flipped up), these systems have generally proven to be reliable. Proper setup to ensure the infeed table is coplanar to the cutterhead is critical, so commissioning and user supervision that this alignment is done properly is well advised.

The outfeed table rocks up/down at the cutterhead only, the end furthest from the cutterhead is swivel mounted on studs (16) attached to the chassis so the table can teeter-totter, but it only elevates at the end closest to the cutterhead. The elevation system is a rotating shaft with eccentric cam at each end (19) turning in a block (20) attached to the machine chassis via studs (15). The cam shaft rotation is actuated via a screw mechanism (6) from above. Since the infeed table tilts, there is no critical alignment required between the outfeed and infeed table, other than they are both coplanar to the cutterhead circumference, assuming the tables themselves are dead flat. It is the case however, that as the outfeed table is raised or lowered, it tilts and thus does not maintain the same coplanar relationship with the infeed table. Since the infeed table tilt is also continuously variable, the infeed table can be brought back into alignment with the outfeed table in a simple manner, thus eliminating the need for complex under-the-hood alignment systems. Again, there isn't enough detail here to comment on the robustness of the components used, but this outfeed table system is vastly superior to that of the Dual 51 and is only made simple by virtue of the fact that the infeed table tilts, thus eliminating the need for critical alignment between the two tables.

The design looks sound to me, but again, I cannot tell from this drawing the robustness of the materials used. I'm pleasantly surprised at the elegance of this system. It's not cheap to build, and factory alignment of the parallelogram system with jigs and fixtures is required to make sure the tables behave properly, but this design if well executed in material strengths and alignment should function well.