FICEP
FICEP NEWS 14/2020
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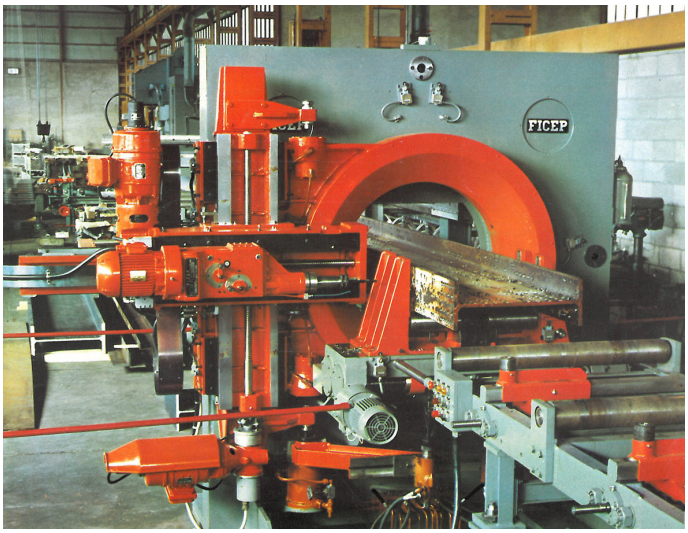
# Review of Drill Line Systems Designs

90 YEARS
ANNIVERSARY
1930 - 2020

Structural steel drill line productivity has been debated by fabricators and machine tool manufacturers as firms started to enter this market after FICEP introduced the first one pass drilling line to the industry in the early 60's.




Initially the debate centered on drilling feeds and speeds. Once sufficient spindle power was achieved the restrictive limitation of this analysis was actually the twist drill.

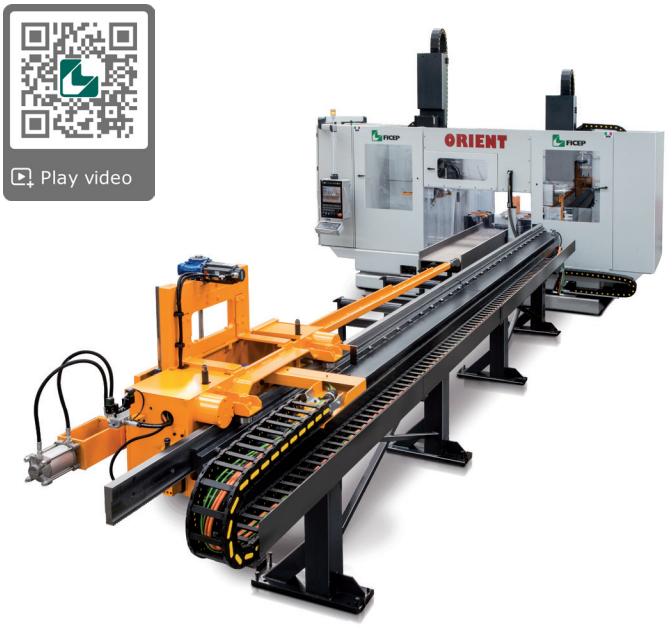
As high-speed steel oil hole drills entered this application, the feed rates increased 3-4 times. At this time the technology started to compete with punching of structural steel in some applications. As the tooling technology expanded to include carbide insert tools, drill line manufacturers started to introduce positive spindle feeds, enhanced mechanical stability of the drill line and improved material clamping to take full advantage of carbide tooling.
Once again, the drilling feed rates improved another 3-4 times over high-speed steel oil hole twist or insert drills.

This substantial reduction in the time required to drill a hole in structural steel focused the productivity debate in other areas such as spindle positioning speeds, elimination of material clamping cycles and reducing the non-productive time of advancing the spindle up to the material surface and the withdraw of the drill from a completed hole.

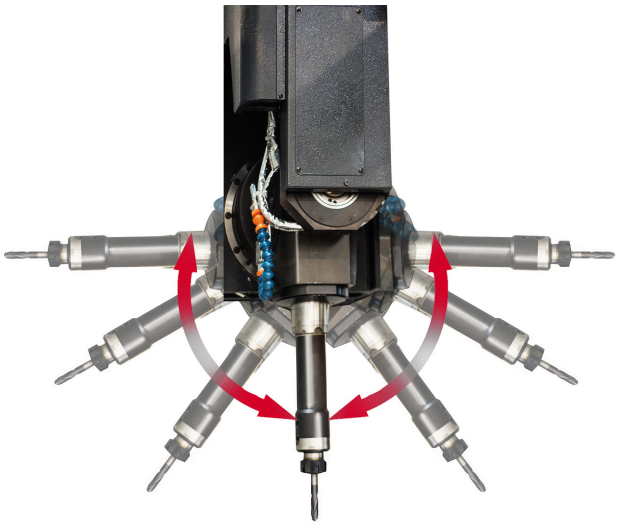
The current productivity focus evolves around increasing the efficiency of spindle engagement in the material. This challenge has stimulated a diversion of basic drill line designs with varied degrees of spindle engagement delivering a wide range of system productivity and capability between basic drill line designs.

Each of the current drill line designs addresses different market segments and applications. The capabilities and advantages of each design type delivers a user the opportunity to match the specifics of their economics and fabrication task to the technology available.
The following provides a review of the specifics and details highlighting their advantages and capabilities.

## Articulating Spindle Drilling Line




Drill lines with articulating spindles are furnished with either one or two spindles to address all three surfaces of structural steel sections.
This spindle articulation capability provides a reduction in the required mechanical and electrical components, which generates additional simplicity when compared with three spindle lines.



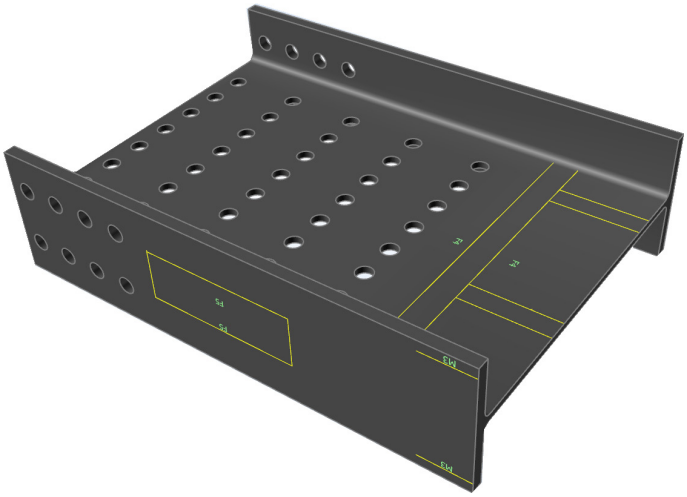
Since a maximum of two spindles can be provided in this configuration the ability to generate holes in a flange and the web can occur simultaneously, assuming all these holes share the same length dimension.

A layout point can be generated by short stroking the drill spindle that can be used as a reference for subsequent additional manual layout.

This design type is available with automatic tool changing, which in conjunction with a positive spindle feed, enables not just drilling but also scribing one surface at a time as well as tapping and countersinking.

Milling is not practical in this case as it would require moving the steel section in conjunction with the spindle. The issue is that when you consider the mill tolerances of a structural steel section's surface, its elevation can change during positioning. This, in conjunction that the section is not rigidly clamped in place, creates inconsistent loading on the milling tool and corresponding vibration.
The only way to minimize the vibration and increase the tooling life in this case is to reduce the feed rates below an acceptable level. This is why scribing tools are spring-loaded to enable the tool to float as the position of the steel surface changes. This tool floating capability of the scribing tool maintains a consistent chip load during positioning.

FICEP's patented software automatically extracts the coordinate location from the CAD drawing of intersecting members and assigns programming commands to establish their location, the part number of the intersecting elements and welding symbols if required.
This information, in conjunction with a floating scribing tool, enables this marking operation.



Even if the two-spindle version of this design is considered, only one surface can be scribed at a time.
Underside scribing is also available but, again, only one surface can be scribed at a time.

**Articulating spindle drilling line with independent sub-axis positioning for each spindle**

This version of drilling line, with sub-axis spindle positioning, has all the capabilities of the version without complementary axis for each spindle plus many additional advantages.

When considering the two-spindle version of this design, both spindles can be engaged in drilling, for example, even when the holes in the pattern do not share the same length axis.

The sub-axis capability of this class of drilling line when furnished with two spindles enables scribing of two surfaces simultaneously as the spindle can move in both the “X” and “Y” axes while the section is clamped.
This enables scribing of the footprint of the intersecting member, its part number and the welding symbol if relevant.

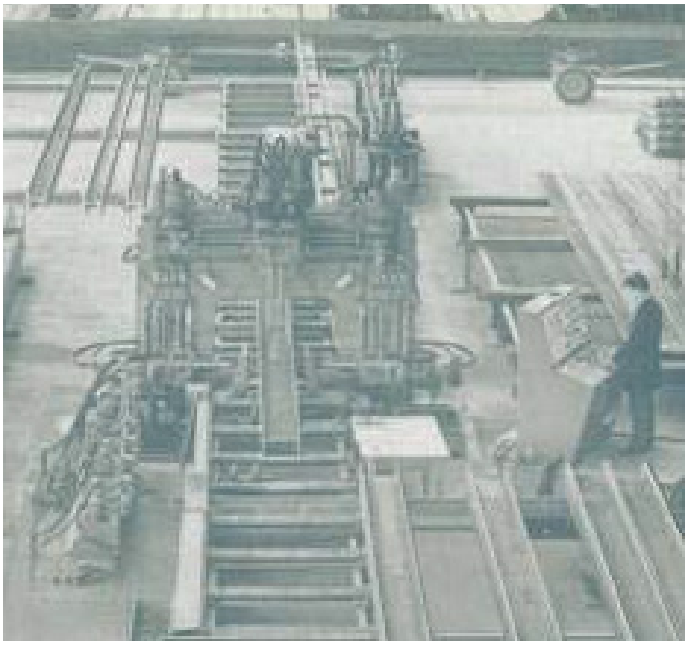
This capability can also be used to generate the part number of the section being processed.

The advantage of the sub-axis spindle capability does not end there as this feature also enables productive milling. Since the steel section is rigidly clamped and only the spindle is being positioned during milling, the irregularities of the steel shape is not a challenge. This results in productive milling rates with exceptional tool life as vibrations that are generated when trying to mill a section in motion is eliminated.

This ability to generate productive milling is typically used to generate slots, large holes that exceed the system’s drilling capability, weld prep with rat holes, mechanical openings, flange thinning and copes, for example.

Both drill spindles can accomplish simultaneous scribing in addition to the underside scribing with this versatile capability.

## Traditional Three-Spindle Drilling Line



FICEP invented the first automatic one pass line to process structural steel in the early 60's.
This invention consisted of a separate drill spindle for each flange and the web. While there have been significant advancements of this basic configuration over the past six decades, it is a design that has been copied by machine tool manufacturers worldwide.

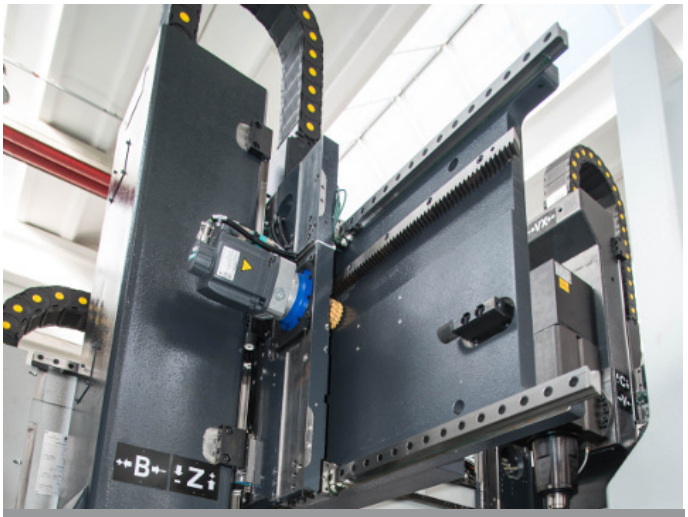

This configuration has the ability to generate holes in both flanges and the web simultaneously, assuming all these holes share the same length dimension.

As innovations were developed for this basic design type, the integration of automatic tool changers has become almost standard.
This tool change capability, in conjunction with the evolution from hydraulic spindle feeds to positive feeds, enabled not just drilling at more productive rates but also scribing, tapping and countersinking.

Milling is not really practical, like in the case of the articulating spindle designs without sub axis positioning, as it requires movement of the steel section in conjunction with the spindle. The issue is the mill tolerances of the structural steel sections as the position of the surface changes during positioning. Like in the case with the articulating spindle design, without sub axis positioning, the section is not rigidly clamped in place, which creates inconsistent loading on the milling tool and vibration.
To minimize the vibration and increase the tooling life it is necessary to reduce the feed rates below an acceptable level.

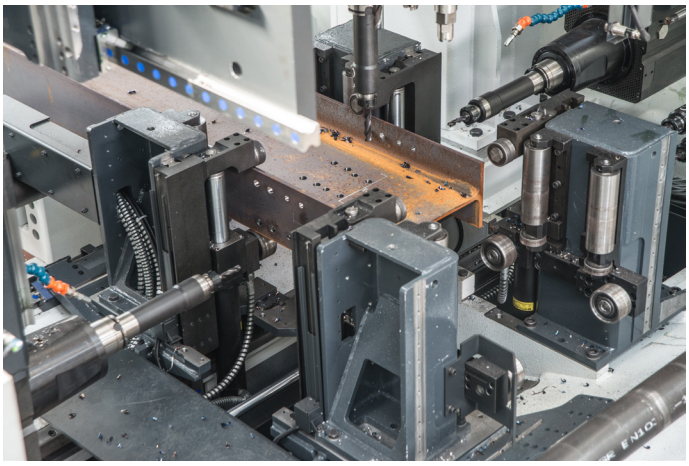
FICEP's patented software automatically extracts from the CAD drawing the coordinate location of intersecting members and assigns the programming commands to establish their location, the part number of the intersecting elements and welding symbols if required.
This information, in conjunction with a floating scribing tool, enables this function. Even with the three-spindle version of this design, however, only one surface can be scribed at a time.
Underside scribing is also available but, again, only one surface can be scribed at a time.


This version of drilling lines with sub-axis spindle positioning has all the capabilities of the version without complementary axis for each spindle and many additional advantages.
The ability to generate independent sub-axis spindle positioning is the most significant enhancement to three spindle drilling lines in their six-decade history. The uniqueness of this design has been confirmed as FICEP has been awarded with applicable patents in most industrial markets.

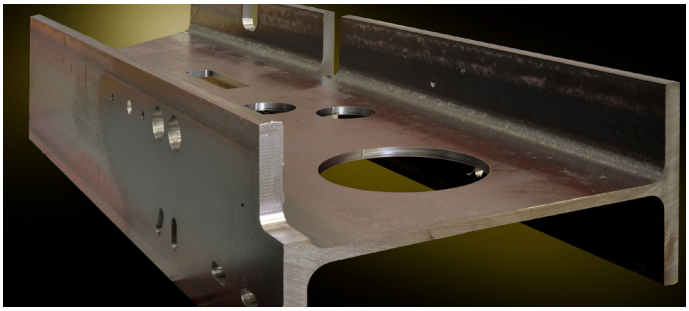



*300 mm sub-axis for each drilling unit*

The addition of this feature has led to the explosion of both productivity and versatility over three spindle drill lines without sub-axis positioning. When drilling offset holes in all three surfaces, the three spindle drilling line with independent spindles and sub-axis positioning proves to be over three times faster.



The advantage of the sub-axis spindle capability does not end there as this feature also enables productive milling.
Since the steel section is rigidly clamped and only the spindles are being positioned during milling, the mill tolerance deviations of the shape is not a challenge. This results in being able to generate productive milling rates and routines with exceptional tool life when compared to vibrations that are generated when trying to mill a section that is moving in one axis and the spindle in a second axis.



This ability to generate productive milling on multiple surfaces simultaneously is used to generate weld prep with rat holes, slots, large holes, mechanical openings, flange thinning and copes, for example.

All three drilling spindles can accomplish scribing on both flanges and the web of different data simultaneously. In addition, the underside scribing capability (4th side) can also be generated simultaneously with its sub-axis capability for additional productivity.

*Underside web scribing device*

It has been almost 60 years since FICEP introduced the first one pass drill line with three spindles.

The fact that lines with an enhanced version of this pioneering design are still available in the market speaks volumes for the creativity of this invention in the early 60's. Certainly the current development of three spindle drill lines with independent sub-axis positioning represents the most significant enhancement to three spindle drill lines during this 6-decade period.

When you consider the substantial increases in drilling and scribing productivity coupled with the expanded milling capabilities, it is difficult to conclude that the economics are not justified in most cases.

The focus of this article, however, is to break down the different drill line design types; highlight their capabilities and limitations.
Each drill line type has a place based upon the specifics of an application. A complete review of both the current and future parts with their anticipated production requirements determines the right fit in the end.

The comprehensive and expansive nature of the FICEP lineup of drill line models eliminates the need to compromise to make one or two models fit an application.