A conveyor for sealed environs

A novel linear motor moves parts within special manufacturing environments without breaching the area with power and control cables.

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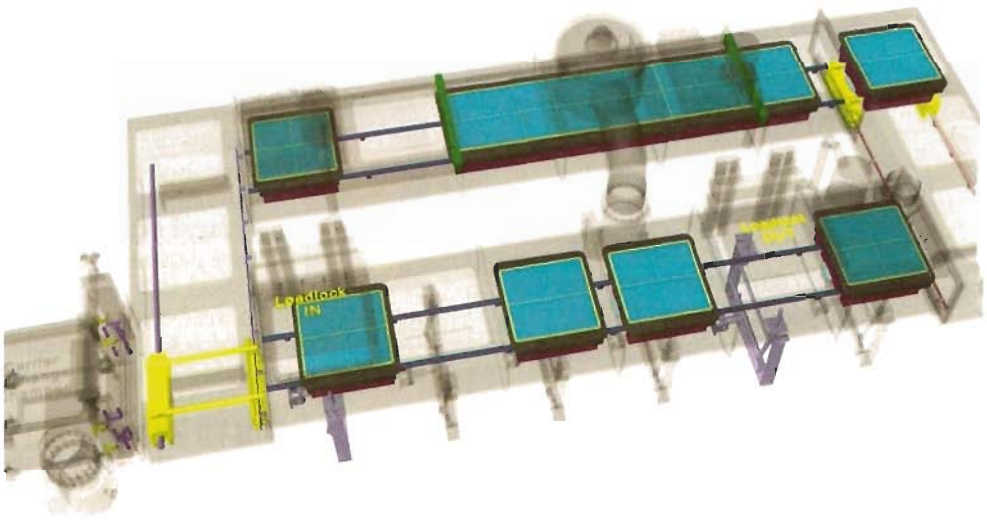

The transport system for manufacturing solar cells operates completely in vacuum. Products move from the Loadlock IN position to Loadlock OUT stopping at up to 18 process stations along the way.

Consider manufacturing or assembly processes set up inside a clean room or vacuum environment. The transport systems used in these settings face far more critical demands then those used to assemble toasters. To meet those demands, the Electric Drives and Controls group from **Bosch Rexroth Corp.** worked with **Tecnotion** to produce a special transportation system.

The system has proven itself for the **OTB Group** (*www.otb.nl*), a maker of solar cells in the Netherlands. Solar-cell fabrication requires a high-vacuum environment in which precision parts move continuously. The transport system must maintain great accuracy while the delicate assembly and manufacturing operations take place in vacuum.

The Linear Motion System (LMS) fosters accuracy by using intelligent coils placed outside the vacuum environment. Only the moving parts that convey the products sit in vacuum. The transportation system is modular, expandable, and easily adapts to transported items. There are no mechanical or electrical feedthroughs from the external control system to penetrate the vacuum environment.

The basic concept is that of a linear motor. A standard linear motor has fixed magnets attached to a frame while a coil travels along the magnets. The same principle can work the other way around: Fix the coils in position and let the magnet move from coil to coil. With the magnet attached to a carrier, the carrier follows the magnet motion. The carrier can move over long distances when the spacing between multiple coils is less than the length of the carrier magnet.

Possible applications that could make use of this design include manufacturing lines for displays, optical equipment, and solar cells as well as any process done in a vacuum, clean-room, aseptic, or gas-sensitive environment.

While the basic technical concept is brilliantly simple, implementation involved complex technical issues. One problem concerned measuring the true position of each carrier without physical contact. Likewise, the transition from coil to coil must take place as smoothly as possible. Each carrier had to have individual speed control with the ability to stop at specific points for

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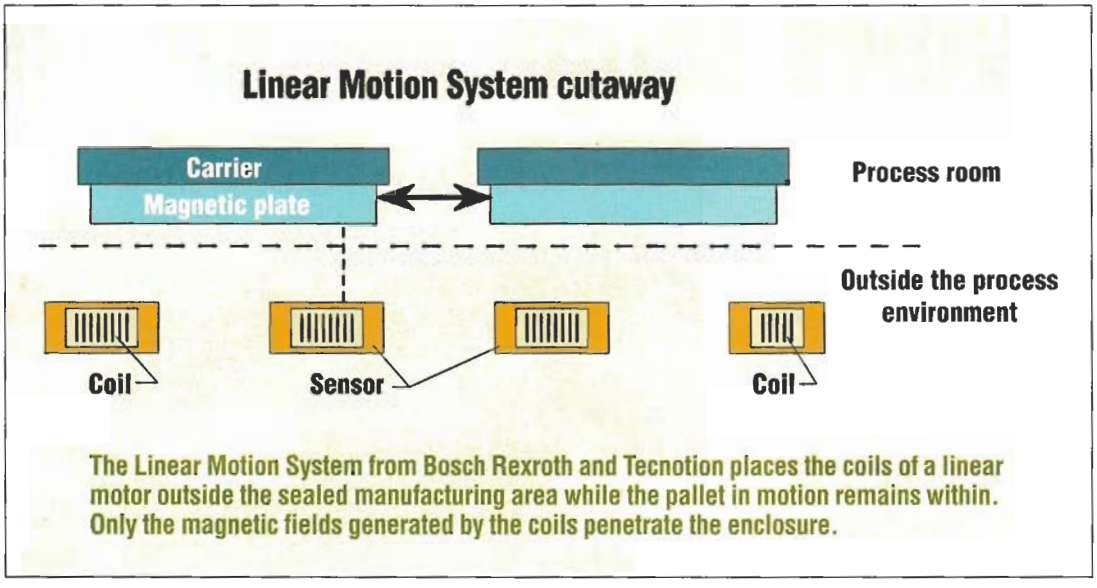
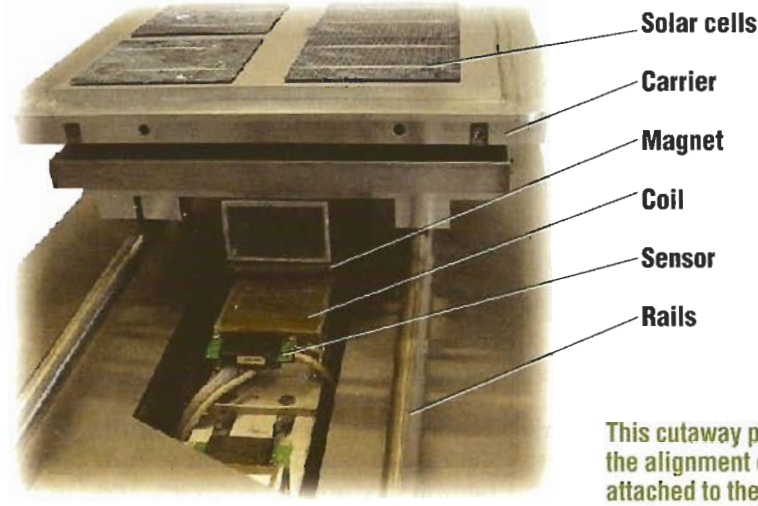
the next process step. With differing speeds comes the possibility of collision. A precollision detector prevents one carrier from bumping another, especially critical when operations take place at the nanometer level on the stopped carrier. Finally, multiple carriers should move like a "train" to transport larger products.



The Linear Motion System from Bosch Rexroth and Tecnotion places the coils of a linear motor outside the sealed manufacturing area while the pallet in motion remains within. Only the magnetic fields generated by the coils penetrate the enclosure.

Different applications dictate different types of linear motors, so the carrier system can use either standard iron core or ironless linear motors. This versatility lets engineers at Tecnotion and Bosch Rexroth adapt the carrier system to specific needs. Carrier temperature can reach 110°C while working in a vacuum of 10^{-7} mbar and IP62 environments. Speeds can hit 5 m/sec and forces 10,000 N, depending on motor configuration and system design.



This cutaway photo shows the alignment of the magnet attached to the solar cell carrier, the coil, and Hall-effect sensors of the linear drive motor. Normal operation would place the coils and sensors outside the sealed process environment of the carrier.

Analog Hall-effect sensors built into the linear-motor core monitor the position of the magnet plate within an accuracy of 200 μm. Resolution is typically 10 to 20 μm with repeatability within 40 μm.

The carrier uses NYCe4000 integrated motion controllers from Bosch Rexroth connected via a network to a PC or PLC to run the user interface part of the control software. Each controller handles up to 10 coils with the coil drive electronics integrated in the NYCe4000. **MD**

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