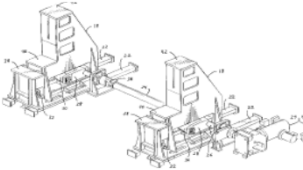
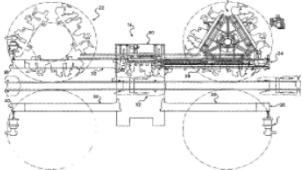
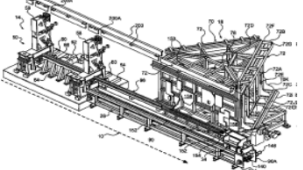
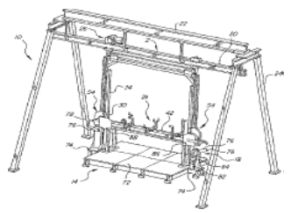
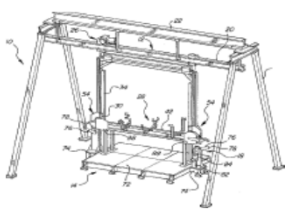
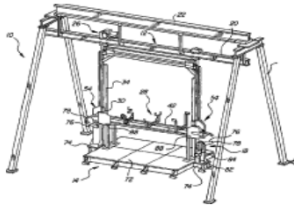
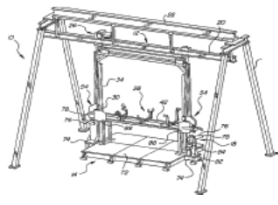
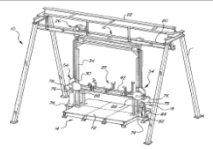
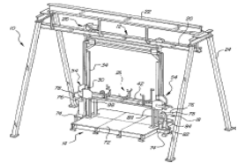
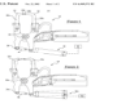
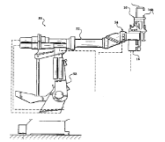
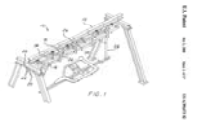
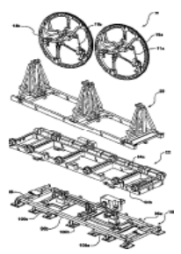


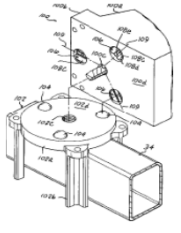
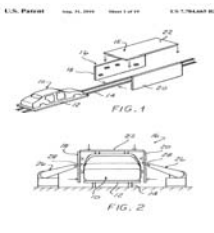
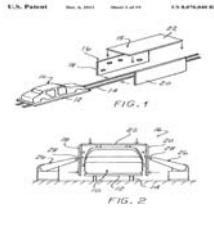
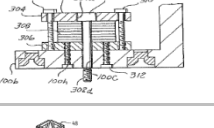
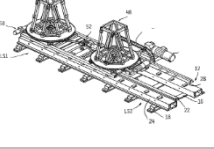
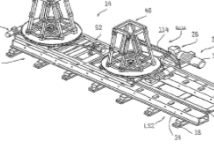
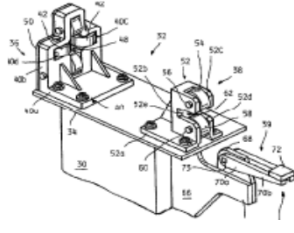
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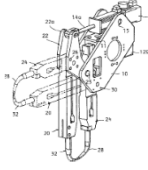
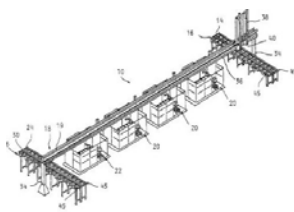
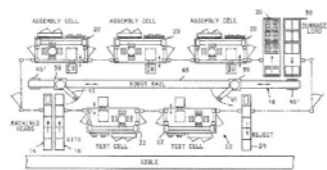
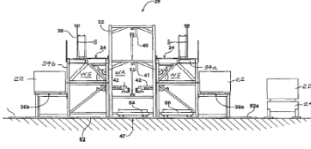
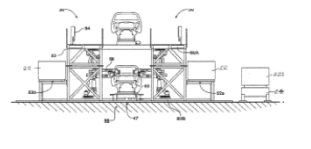
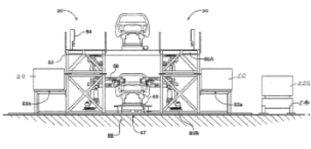
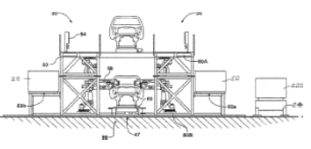
Patent/Reg Number	Title	Illustration	Description
6,173,881	Car Body Assembly and Welding Station with Reciprocal Gate-supporting System		A vehicle body welding system includes a work station for welding components of a preassembled body with respect to one another. The body is moveable along a fixed path of travel through the work station. At least two moveable pillars are located on each side of the fixed path of travel through the work station for synchronized reciprocation between first and second end limits of travel toward and away from the fixed path of travel of the body. At least one gate is connectible in a repeatable located position with respect to the moveable pillars on each side of the fixed path for synchronized reciprocation between first and second positions toward and away from the fixed path of travel of the body. Locating members are engageable between each pillar and the corresponding gate for locating the gate with respect to the moveable pillar in at least two dimensions. The locating members include at least two vertically spaced locators on each pillar for defining a vertical position and a horizontal position along an axis normal to the fixed path, and a moveable locator for locating the gate in a predetermined position along an axis parallel with respect to the fixed path of travel of the body, when the moveable locator is in a first position, and for allowing movement of the gate with respect to the pillars, when the moveable locator is in a second position.
6,932,263	Vehicle Framing System for Plurality of Vehicle Body Styles		An apparatus and method for randomly interchanging up to four pairs of side framing gates at a framing station of a vehicle assembly line while maintaining a predetermined build cycle time interval of the assembly line. The system employs first and second carousels positioned on opposite sides of the assembly line upstream of the framing station and third and fourth carousels positioned on opposite sides of the production line downstream of the framing station. The system further includes a first linear track structure extending from the first carousel to a first side of the framing station, a second linear track structure extending from the second carousel to a second, opposite side of the framing station, a third linear track structure extending from the third carousel to the first side of the framing station, a third linear track structure extending from the third carousel to the first side of the framing station, and a fourth linear track structure extending from the fourth carousel to the second side of the framing station. The carousel includes at least two sides, possibly three sides, four sides or more, each side capable of receiving a framing gate. The framing gates positioned at the framing station are randomly interchanged by a combination of rotary movements of the carousels and linear movements of framing gates along the linear track structures.
7,510,109	Vehicle Framing System for Plurality of Vehicle Body Styles		An apparatus and method for randomly interchanging up to four pairs of side framing gates at a framing station of a vehicle assembly line while maintaining a predetermined build cycle time interval of the assembly line. The system employs first and second carousels positioned on opposite sides of the assembly line upstream of the framing station and third and fourth carousels positioned on opposite sides of the production line downstream of the framing station. The system further includes a first linear track structure extending from the first carousel to a first side of the framing station, a second linear track structure extending from the second carousel to a second, opposite side of the framing station, a third linear track structure extending from the third carousel to the first side of the framing station, a third linear track structure extending from the third carousel to the first side of the framing station, and a fourth linear track structure extending from the fourth carousel to the second side of the framing station. The carousel includes at least two sides, possibly three sides, four sides or more, each side capable of receiving a framing gate. The framing gates positioned at the framing station are randomly interchanged by a combination of rotary movements of the carousels and linear movements of framing gates along the linear track structures.
6,719,122	Lockable Latch for a Lowerator Having a Combined Latch Actuation and Carrier Movement		A lowerator for an assembly system of the type including at least one rail defining a path of travel with respect to at least one workstation, and a conveyor for transporting a workpiece along the rail. The conveyor includes a trolley moveable along the rail and a carrier moveable with respect to the trolley. The carrier supports a workpiece during movement with respect to the workstation. The carrier is vertically positionable between a raised position and lowered position with respect to the trolley. The lowerator moves the carrier between the raised and lowered positions and cycles a latch for securing the carrier to the trolley when in the raised position. The lowerator includes at least one lifter or actuator defining a path of travel in at least a first direction, where the lifter actuates the latch to uncouple the trolley and carrier before moving the carrier into the lowered position at the workstation so that one or more processing operations can be performed on the workpiece. A lock, including a reciprocal pin and rotatable catch, can operably engage the latch in an engaged position for holding the carrier in the raised position with respect to the trolley. A lockout pin can be operably positioned to obstruct free movement of the latch from the engaged position until the lockout pin is removed. A guide member can be associated with each carrier for engagement with a guide channel located at the workstation for guiding movement of the carrier between the raised and lowered positions.
6,554,119	Flexible Automotive Assembly Line and Method		An apparatus for assembling an automotive body on an assembly line having a right-hand body subassembly line, a left-hand body subassembly line and an underbody subassembly line, for delivery to a pallet transport system for movement through a body framing subassembly line. The apparatus includes an overhead transport system for transporting automotive components along at least one of the subassembly lines and for conveying the automotive components along a pallet transport system on the body framing subassembly line. The overhead transport system includes a trolley movable along a single overhead rail, a carriage slidably movable relative to the trolley, and a plurality of antler nests. Each antler nest is individually engageable with the carriage. The apparatus also includes a lowerator for transferring components from the overhead transport system to a geometry fixture at a workstation along the subassembly line. The workstation along the subassembly line can include a plurality of geometry fixtures that are exchangeable at a ready position of the workstation.

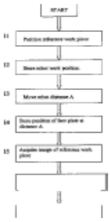
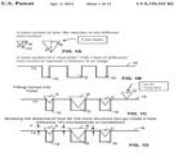
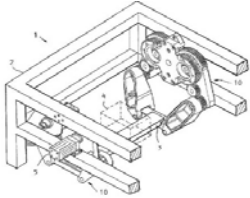
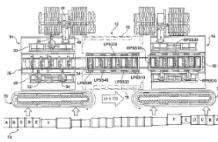
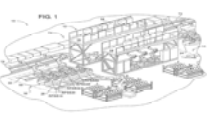
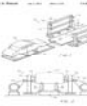
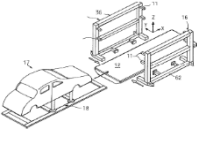
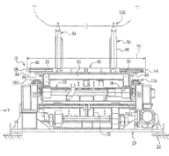
Patent/Reg Number	Title	Illustration	Description
6,827,197	Flexible Automotive Assembly Line and Method		An apparatus for assembling an automotive body on an assembly line having a right-hand body subassembly line, a left-hand body subassembly line and an underbody subassembly line, for delivery to a pallet transport system for movement through a body framing subassembly line. The apparatus includes an overhead transport system for transporting automotive components along at least one of the subassembly lines and for conveying the automotive components along a pallet transport system on the body framing subassembly line. The overhead transport system includes a trolley movable along a single overhead rail, a carriage slidably movable relative to the trolley, and a plurality of antler nests. Each antler nest is individually engageable with the carriage. The apparatus also includes a lowerator for transferring components from the overhead transport system to a geometry fixture at a workstation along the subassembly line. The workstation along the subassembly line can include a plurality of geometry fixtures that are exchangeable at a ready position of the workstation.
7,128,196	Flexible Automotive Assembly Line Method		An apparatus for assembling an automotive body on an assembly line having a right-hand body subassembly line, a left-hand body subassembly line and an underbody subassembly line, for delivery to a pallet transport system for movement through a body framing subassembly line. The apparatus includes an overhead transport system for transporting automotive components along at least one of the subassembly lines and for conveying the automotive components along a pallet transport system on the body framing subassembly line. The overhead transport system includes a trolley movable along a single overhead rail, a carriage slidably movable relative to the trolley, and a plurality of antler nests. Each antler nest is individually engageable with the carriage. The apparatus also includes a lowerator for transferring components from the overhead transport system to a geometry fixture at a workstation along the subassembly line. The workstation along the subassembly line can include a plurality of geometry fixtures that are exchangeable at a ready position of the workstation.
6,557,690	Interchangeable Nests for Supporting Components on a Transport System		An apparatus for transporting a plurality of automotive body styles along an assembly line. The apparatus includes a plurality of antler nests, at least one antler nest for each automotive body style to be processed on the assembly line. Each antler nest is transported along the assembly line by a carriage. An exchanging station is provided to exchange one antler nest for another. The antler nests can be exchanged while a rate of production on the assembly line is maintained.
6,564,440	Flexible Automotive Assembly Workstation and Method		An apparatus for assembling multiple automotive body styles on a single assembly line. The apparatus includes a workstation with multiple geometry fixtures, at least one geometry fixture for each automotive body style to be processed at the work station. One geometry fixture is at a ready position of the work station to support an automotive component during a processing operation. The geometry fixtures can be exchanged at the ready position so that a production rate of the assembly line can be maintained. The apparatus also includes a lowerator for transferring an automotive component from an overhead transport system to the geometry fixture at the ready position.
6,469,272	Weld Gun with Inverted Roller Screw Actuator		A weld gun having a pair of opposing arms movable relative to each other to apply pressure to a workpiece during a welding operation. The opposing arms of the weld gun can be rotatable or translatable relative to each other. The opposing arms are moved relative to each other by an inverted roller screw linear actuator. The weld gun can include an electric control for controlling the operation of the actuator. The actuator can be mounted on either of the opposing arms.
6,787,729	Multiaxis Articulatable Robot Having a Weld Gun with Inverted Roller Screw Actuator		A multi-axis articulatable robot with a weld gun having a pair of opposing arms, where at least one arm is movable relative to the other arm to apply pressure to a workpiece during a welding operation. At least one of the opposing arms of the weld gun can be rotatable or translatable relative to the other arm. At least one arm is moved relative to the other arm by an inverted roller screw linear actuator. The robot can include an electric controller for controlling the operation of the actuator of the weld gun as an additional axis of the robot movement. The actuator can be mounted on either of the opposing arms.
6,799,673	Versaroll Overhead Conveyor System		An overhead conveyor or transport system is disclosed where at least one carriage is supported on a plurality of rollers rotatably mounted in fixed overhead locations spaced along a path of travel. At least one motor is provided for driving a portion of the plurality of rollers in rotation along at least one segment of the path of travel. Each carriage has at least one elongate support member operably engagable with the rollers for movement along the path of travel in response to rotation of the rollers. The elongate support member is continuously engagable with at least two rollers simultaneously while the corresponding carriage is moved along the path of travel. Each carriage or carrier hangs downwardly below the rotational axis of the overhead rollers.
6,912,774	Apparatus and Method for Assembly of Motorcycle Frame		A method and apparatus for assembling motorcycle frames includes a conveyor defining a path of travel and at least one pallet movable along the conveyor through at least one workstation. The pallet supports at least one rotatable frame for receiving individual components and/or subassemblies in fixed relationship with respect to one another in a geometry fixture. The angular position of the rotatable frame and supported geometry fixture can be reoriented about an axis of rotation by engagement with a drive motor. The rotatable frame is normally locked in an angular orientation with respect to the pallet. When the movable section of the conveyor and supported pallet are moved, the movable section of the conveyor is guided between raised and lowered positions with respect to the workstation, and the support pallet is accurately and repeatedly positioned with respect to the workstation for automated processing operations at the workstation.


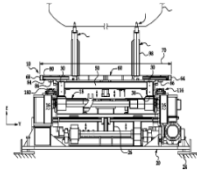
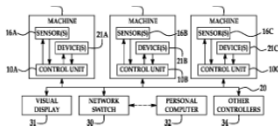

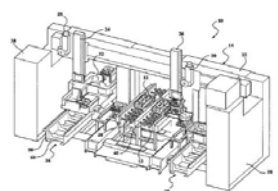
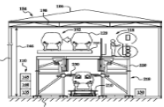
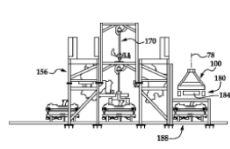
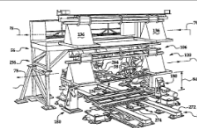
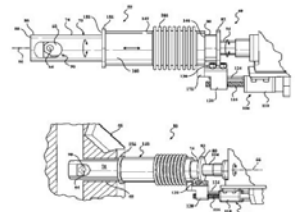
Patent/Reg Number	Title	Illustration	Description
6,911,616	Weld Gun Assembly		A weld gun for performing a welding operation on a workpiece includes a pair of opposing arms, at least one arm movable relative to the opposing arm to apply pressure to the workpiece during a welding operation. A pair of identical or mirror image side plates support components of the weld gun to establish critical dimensions of the components relative to one another, while preventing tolerance buildup of critical dimensions at critical points. A guide block is connected to one of the opposing arms. The guide block has a non-circular aperture formed therein. An electrode adapter has a non-cylindrical rod portion slidably received in the non-circular aperture formed in the guide block for preventing rotation of the electrode adapter. A hose fitting is attachable directly to a rear end of the electrode adapter for communicating with an inlet water port and an outlet water port formed in the electrode adapter for providing a routing of coolant directly through the electrode adapter only.
6,723,944	Pinch Weld Gun		A pinch type weld gun wherein the weld arms are pivotally mounted on the frame structure via a ball bearing structure including annular members of insulative material positioned in apertures in the weld arms, inner races fixedly mounted on a common pivot pin, outer races positioned within the respective insulative annular members, and ball races positioned between the respective inner races and respective outer races. A shunt is fixedly secured at one end thereof to a gun electrode and fixedly secured at another end thereof to the gun transformer, and the other end of the shunt defines a coolant passage communicating with the transformer coolant passage system whereby coolant may be delivered to the transformer coolant passage system through the coolant passage in the other end of the shunt. A second shunt fixedly secured at one end thereof to a further electrode and fixedly secured at another end thereof to the transformer defines a further coolant passage in the other end thereof communicating with the transformer coolant passage system so that the coolant may be delivered to the transformer coolant passage system through the coolant passage in the other end of the first shunt and discharged from the transformer coolant passage system through the coolant passage in the other end of the second shunt to provide a continuous flow of coolant through the transformer coolant passage system. A cooling liquid distribution block is mounted on the gun frame at a location remote from the electrodes and concentric tubing extends from the distribution block to the electrodes for respective connection to concentric passageways defined in the electrodes.
6,966,427	Pallet/Skid Power Roll System		An apparatus moves a plurality of transport media along a path of travel. The plurality of transport media define at least two groups of transport media, where each group of transport media has substantially identical transverse dimensions with respect to one another within one group of transport media, while having substantially different transverse dimensions with respect to another group of transport media. The apparatus includes a plurality of rollers rotatably mounted in fixed locations spaced along a path of travel. At least one motor is provided for driving at least one of the rollers in rotation. At least one transport media is supported on the rollers for movement along the path of travel in response to rotation of the roller by the motor. Each transport media has at least one elongate support member continuously engageable with at least two rollers simultaneously while the transport media moves along the path of travel. A lift workstation can be located along the path of travel for transferring a workpiece carried by one transport media to another transport media.
7,232,027	Pallet/Skid Power Roll System		An apparatus moves a plurality of transport media along a path of travel. The plurality of transport media define at least two groups of transport media, where each group of transport media has substantially identical transverse dimensions with respect to one another within one group of transport media, while having substantially different transverse dimensions with respect to another group of transport media. The apparatus includes a plurality of rollers rotatably mounted in fixed locations spaced along a path of travel. At least one motor is provided for driving at least one of the rollers in rotation. At least one transport media is supported on the rollers for movement along the path of travel in response to rotation of the roller by the motor. Each transport media has at least one elongate support member continuously engageable with at least two rollers simultaneously while the transport media moves along the path of travel. A lift workstation can be located along the path of travel for transferring a workpiece carried by one transport media to another transport media.
7,108,189	Precise Transport Positioning Apparatus Using a Closed Loop Controlled, Non-Direct Drive or Friction Drive System with Absolute Positioning Encoder		An apparatus for positioning a workpiece carrier with respect to a workstation can include an encoder reader located in a fixed position at a workstation for generating a signal in response to interaction with at least one encoder strip, a workpiece carrier movable along a path of travel through the workstation, and having an encoder strip connected thereto, the encoder strip operably interacting with the encoder reader located at the workstation, and a non-direct drive or friction drive engaging the workpiece carrier for moving the carrier along the path of travel through the workstation, the non-direct drive or friction drive responsive to the signal from the encoder reader in a closed loop feedback control system. The encoder reader can be selected from a group consisting of an optical encoder reader, a magnetic encoder reader, and any other absolute positioning encoder reader. A closed loop feedback control system can be provided for receiving the signal from the encoder reader, and for generating an output signal in response to the signal from the encoder reader in accordance with a program stored in memory. The encoder reader can be used for generating a signal corresponding to at least one of a position identification signal, a workpiece carrier identification signal, and a workpiece configuration identification signal.

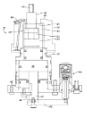
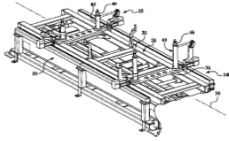
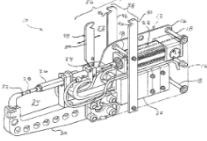
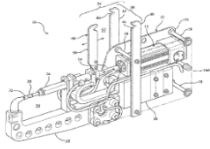
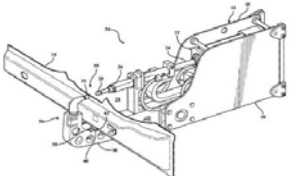
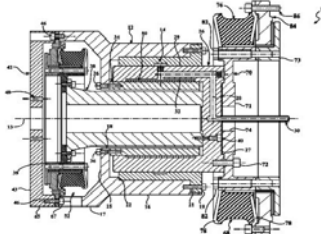
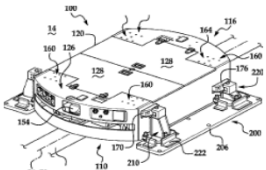
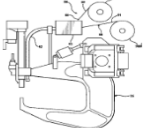
Patent/Reg Number	Title	Illustration	Description
7,416,130	Precise Transport Positioning Apparatus Using a Closed Loop Controlled, Non-Direct Drive Or Friction		An apparatus for positioning a workpiece carrier with respect to a workstation can include an encoder reader located in a fixed position at a workstation for generating a signal in response to interaction with at least one encoder strip, a workpiece carrier movable along a path of travel through the workstation, and having an encoder strip connected thereto, the encoder strip operably interacting with the encoder reader located at the workstation, and a non-direct drive or friction drive engaging the workpiece carrier for moving the carrier along the path of travel through the workstation, the non-direct drive or friction drive responsive to the signal from the encoder reader in a closed loop feedback control system. The encoder reader can be selected from a group consisting of an optical encoder reader, a magnetic encoder reader, and any other absolute positioning encoder reader. A closed loop feedback control system can be provided for receiving the signal from the encoder reader, and for generating an output signal in response to the signal from the encoder reader in accordance with a program stored in memory. The encoder reader can be used for generating a signal corresponding to at least one of a position identification signal, a workpiece carrier identification signal, and a workpiece configuration identification signal.
8,109,443	Precise Transport Positioning Apparatus Using a Closed Loop Controlled, Non-Direct Drive Or Friction		An apparatus for positioning a workpiece carrier with respect to a workstation can include a workpiece carrier movable relative to the workstation and having an encoder strip, at least one encoder reader located at the workstation for generating a signal in response to interaction with at least one encoder strip, and a drive engaging the workpiece carrier for moving the carrier relative to the workstation, the drive responsive to the signal from the encoder reader. The encoder reader can be selected from a group consisting of an optical encoder reader, a magnetic encoder reader, and any other absolute positioning encoder reader. A closed loop feedback control system can be provided for receiving the signal from the encoder reader, and for generating an output signal in response to the signal from the encoder reader in accordance with a program stored in memory. The encoder reader can be used for generating a signal corresponding to at least one of a position identification signal, a workpiece carrier identification signal, and a workpiece configuration identification signal.
8,733,661	Precise Transport Positioning Apparatus Using a Closed Loop Controlled . . .		An apparatus for positioning a workpiece carrier with respect to a workstation can include a workpiece carrier movable relative to the workstation and having an encoder strip, at least one encoder reader located at the workstation for generating a signal in response to interaction with at least one encoder strip, and a drive engaging the workpiece carrier for moving the carrier relative to the workstation, the drive responsive to the signal from the encoder reader. A closed loop feedback control system can be provided for receiving the signal from the encoder reader, and for generating an output signal in response to the signal from the encoder reader in accordance with a program stored in memory.
6,948,227	Framing Station Having Self Piercing Rivets		An apparatus and process for assembling individual body components of a body-in-white vehicle with respect to one another to form a unitary vehicle body including a framing workstation for receiving and positionally locating an under-body member of the vehicle, and for receiving and positionally locating at least one upper body member of the vehicle with respect to the underbody member. The framing workstation establishing a predetermined geometry of the individual body components, while forming the unitary vehicle body. At least one self-piercing rivet tool for securing the at least one upper body member of the vehicle to the underbody member of the vehicle to form and maintain the predetermined geometry of the unitary vehicle body with self-piercing rivets.
7,896,217	Welding Station Frame Apparatus with Breakaway Provision		A motor vehicle car body framing apparatus for use at a welding station, the apparatus including a gate having a frame structure and a plurality of tooling members carried by the frame structure for use in positioning components of the vehicle body at the welding station for welding. The tooling members are mounted on the frame structure by a plurality of mounting brackets. Each mounting bracket includes a base member mounted on the frame structure and a riser mounted on the base and mounting a respective tooling member. The riser is fixedly mounted on the base by a single central fastener bolt which may include a reduced diameter portion sized to break away in response to predetermined impact against the riser. The triangulated mounting interface between the base and the riser arranged in concentric relation to the fastener bolt. The triangulated mounting interface may comprise a raised ring surface on one of the base and the riser centered on the axis of the fastener bolt and positioned at the mounting interface of the base and the riser. Each mounting bracket further includes two dowels received in aligned apertures in the base and in the riser at locations flanking the axis of the fastener bolt.
8,109,429	Welding Station Frame		A motor vehicle car body framing apparatus for use at a welding station, the apparatus including a gate having a frame structure and a plurality of tooling members carried by the frame structure for use in positioning components of the vehicle body at the welding station for welding. The tooling members are mounted on the frame structure by a plurality of mounting brackets. Each mounting bracket includes a base member mounted on the frame structure and a riser mounted on the base and mounting a respective tooling member. The riser is fixedly mounted on the base by a single central fastener bolt which may include a reduced diameter portion sized to break away in response to predetermined impact against the riser. Each mounting bracket further includes means defining a triangulated mounting interface between the base and the riser arranged in concentric relation to the fastener bolt. The triangulated mounting interface may comprise a raised ring surface on one of the base and the riser centered on the axis of the fastener bolt and positioned at the mounting interface of the base and the riser. Each mounting bracket further includes two dowels received in aligned apertures in the base and in the riser at locations flanking the axis of the fastener bolt.

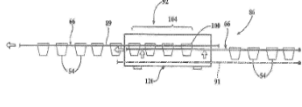
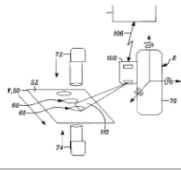
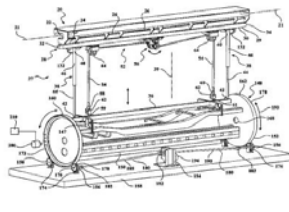
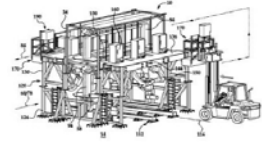
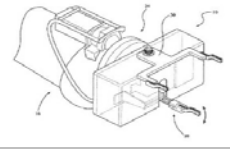
Patent/Reg Number	Title	Illustration	Description
7,271,367	Single Retainer Mounted Riser		A motor vehicle car body framing apparatus for use at a welding station, the apparatus including a gate having a frame structure and a plurality of tooling members carried by the frame structure for use in positioning components of the vehicle body at the welding station for welding. The tooling members are mounted on the frame structure by a plurality of mounting brackets. Each mounting bracket includes a base member mounted on the frame structure and a riser mounted on the base and mounting a respective tooling member. The riser is fixedly mounted on the base by a single central fastener bolt which may include a reduced diameter portion sized to breakaway in response to predetermined impact against the riser. The interface between the riser and the base comprises a plurality of contact points arranged in concentric relation with respect to the fastener bolt. The contact points may comprise a plurality of circumferentially spaced balls mounted on the base for coaction with circumferentially spaced grooves defined on the riser.
7,784,665	Single Retainer Mounted Riser		A motor vehicle car body framing apparatus for use at a welding station, the apparatus including a gate having a frame structure and a plurality of tooling members carried by the frame structure for use in positioning components of the vehicle body at the welding station for welding. The tooling members are mounted on the frame structure by a plurality of mounting brackets. Each mounting bracket includes a base member mounted on the frame structure and a riser mounted on the base and mounting a respective tooling member. The riser is fixedly mounted on the base by a single central fastener bolt which may include a reduced diameter portion sized to breakaway in response to predetermined impact against the riser. The interface between the riser and the base comprises a plurality of contact points arranged in concentric relation with respect to the fastener bolt. The contact points may comprise a plurality of circumferentially spaced balls mounted on the base for coaction with circumferentially spaced grooves defined on the riser. A breakaway bolt assembly replacement kit is also disclosed as well as an arrangement wherein the riser is constituted by an integral extension arm of the tooling member.
8,070,040	Single Retainer Mounted Riser		A motor vehicle car body framing apparatus for use at a welding station, the apparatus including a gate having a frame structure and a plurality of tooling members carried by the frame structure for use in positioning components of the vehicle body at the welding station for welding. The tooling members are mounted on the frame structure by a plurality of mounting brackets. Each mounting bracket includes a base member mounted on the frame structure and a riser mounted on the base and mounting a respective tooling member. The riser is fixedly mounted on the base by a single central fastener bolt which may include a reduced diameter portion sized to breakaway in response to predetermined impact against the riser. The interface between the riser and the base comprises a plurality of contact points arranged in concentric relation with respect to the fastener bolt. The contact points may comprise a plurality of circumferentially spaced balls mounted on the base for coaction with circumferentially spaced grooves defined on the riser. A breakaway bolt assembly replacement kit is also disclosed as well as an arrangement wherein the riser is constituted by an integral extension arm of the tooling member.
8,261,960	Single Retainer Mounted Riser		A fastening device and method for mounting equipment to a framing member. The invention includes a single breakaway fastener that is pretensioned using a biasing member to fracture on a predetermined force applied to the fastened joint to avoid damage to the secured equipment. In one example the device and method includes the fastener having a reduced diameter portion that is positioned between an annular plate and the framing member.
8,042,249	Motor Vehicle Body Assembly Apparatus		A method and apparatus for providing motor vehicle sub-assemblies with unrestricted model mix and quick changeover between models. The apparatus includes a track; a carriage mounted for longitudinal movement along the track between first and second positions; and first and second turrets rotatably mounted on the carriage at longitudinally spaced locations and each including a plurality of circumferentially spaced individual faces and unique tooling fixtures on the respective faces for receiving unique work piece components corresponding to a plurality of motor vehicle body styles.
8,302,281	Motor Vehicle Body Assembly Apparatus		A method and apparatus for providing motor vehicle sub-assemblies with unrestricted model mix and quick changeover between models. The apparatus includes a track; a carriage mounted for longitudinal movement along the track between first and second positions; and first and second turrets rotatably mounted on the carriage at longitudinally spaced locations and each including a plurality of circumferentially spaced individual faces and unique tooling fixtures on the respective faces for receiving unique work piece components corresponding to a plurality of motor vehicle body styles.
7,677,428	Motor Vehicle Body Framing Apparatus		A motor vehicle body framing apparatus located at a welding station of a motor vehicle assembly line for use in precisely positioning body panels arriving at the welding station for welding. The apparatus includes a base structure positioned at the welding station and having a longitudinal extent in the direction of body panel movement and a transverse extent; a parking structure upstanding vertically from the base structure on either side of the welding station and each defining parking devices; and a pair of longitudinal side gates each carrying tooling fixtures for engagement with body side panels and each including parking devices operative in coaction with the parking devices on the upstanding parking structures to precisely position the gates on the parking structure and thereby precisely position the tooling fixtures relative to the body panels. A plurality of sets of gates each having tooling fixtures mounted thereon corresponding respectively to a plurality of motor vehicle body styles are provided and the sets of gates are selectively interchanged utilizing the coacting parking devices so as to readily exchange tooling fixtures to accommodate the plurality of body styles being produced on the assembly line.

Patent/Reg Number	Title	Illustration	Description
8,304,681	Universal Weld Gun Configuration		A weld gun in which the first weld arm is fixedly but removably connected to the weld gun body and the second weld arm includes a first arm segment, pivotally mounted at one end thereof on the gun body and pivotally connected at another end thereof to the gun actuator, and a second arm segment fixedly but removably connected at one end thereof to an intermediate portion of the first arm segment. Conversion of the gun from an X axis configuration to a Y axis configuration is achieved by removing the second arm segment from the first arm segment, removing the first weld arm from the body, rotating the second arm segment and the first weld arm through 90°, attaching the first arm to the first arm segment, and connecting the second arm segment to the body.
8,229,586	Method and Apparatus for Assembling a Complex Product in a Parallel Process System		A method and apparatus for assembling a complex product in a parallel process system wherein a collection of components are provided for assembling the complex product. The present invention involves transferring the collection of the components to one of a plurality of similar computerized assembly cells through the use of a transport system. The collection of components is automatically assembled into the complex product through the use of the computerized assembly cells. The complex product is then transferred from one of the assembly cells to a computerized test cell, where the complex product is tested to ensure for the proper dimensioning and functioning of the complex product. The complex product is then transferred from the test cell via the transport system to either a part reject area or conveyor, if the complex product is defective, or to an automatic dunnage load or part return system, if the complex product is not defective.
8,620,467	Method and Apparatus for Assembling a Complex Product in a Parallel Process System		A method and apparatus for assembling a complex product in a parallel process system wherein a collection of components are provided for assembling the complex product. The present invention involves transferring the collection of components to one of a plurality of similar computerized assembly cells through the use of a transport system. The collection of components is automatically assembled into the complex product through the use of the computerized assembly cells. The complex product is then transferred from one of the assembly cells to a computerized test cell, where the complex product is tested to ensure for the proper dimensioning and functioning of the complex product. The complex product is then transferred from the test cell via the transport system to either a part reject area or conveyor, if the product is defective, or to an automatic dunnage load or part return system, if the product is not defective.
8,201,723	Robotic High Density Welding Body Shop		A method and apparatus for managing the delivery of component parts and tooling to a robotic welding assembly positioned on a motor vehicle body assembly line. Automatic guided vehicles deliver component parts from a source of parts to a parts staging area on the robotic welding assembly including a substage awaiting area, a substage in-use area and a sub stage empty area, and further automatic guided vehicles deliver tooling from a tooling management area to the robotic welding assembly whereafter the tooling, upon model changeover, is moved to a tooling use area proximate the assembly line whereafter, upon further model changeover, the tooling is removed from the tooling use area and loaded onto an automatic guided vehicle for return to the tooling management area.
8,308,048	Robotic High Density Welding Body Shop Divisional Patent Application		A method and apparatus for managing the delivery of component parts and tooling to a robotic welding assembly positioned on a motor vehicle body assembly line. Automatic guided vehicles deliver component parts from a source of parts to a parts staging area on the robotic welding assembly including a substage awaiting area, a substage in-use area and a sub stage empty area, and further automatic guided vehicles deliver tooling from a tooling management area to the robotic welding assembly whereafter the tooling, upon model changeover, is moved to a tooling use area proximate the assembly line whereafter, upon further model changeover, the tooling is removed from the tooling use area and loaded onto an automatic guided vehicle for return to the tooling management area.
8,474,683	Robotic High Density Welding Body Shop		A method and apparatus for managing the delivery of component parts and tooling to a robotic welding assembly positioned on a motor vehicle body assembly line. Automatic guided vehicles deliver component parts from a source of parts to a parts staging area on the robotic welding assembly including a substage awaiting area, a substage in-use area and a sub stage empty area, and further automatic guided vehicles deliver tooling from a tooling management area to the robotic welding assembly whereafter the tooling, upon model changeover, is moved to a tooling use area proximate the assembly line whereafter, upon further model changeover, the tooling is removed from the tooling use area and loaded onto an automatic guided vehicle for return to the tooling management area.
8,733,617	Robotic High Density Welding Body Shop		A method and apparatus for managing the delivery of component parts and tooling to a robotic welding assembly positioned on a motor vehicle body assembly line. Automatic guided vehicles deliver component parts from a source of parts to a parts staging area on the robotic welding assembly including a substage awaiting area, a substage in-use area and a sub stage empty area, and further automatic guided vehicles deliver tooling from a tooling management area to the robotic welding assembly whereafter the tooling, upon model changeover, is moved to a tooling use area proximate the assembly line whereafter, upon further model changeover, the tooling is removed from the tooling use area and loaded onto an automatic guided vehicle for return to the tooling management area.

Patent/Reg Number	Title	Illustration	Description
8,923,602	Automated Guidance and Recognition System and Method of the Same		Disclosed herein are embodiments and methods of a visual guidance and recognition system requiring no calibration. One embodiment of the system comprises a servo actuated manipulator configured to perform a function, a camera mounted on the face plate of the manipulator, and a recognition controller configured to acquire a two dimensional image of the work piece. The manipulator controller is configured to receive and store the face plate position at a distance "A" between the reference work piece and the manipulator along an axis of the reference work piece when the reference work piece is in the camera's region of interest. The recognition controller is configured to learn the work piece from the image and the distance "A". During operation, a work piece is recognized with the system, and the manipulator is accurately positioned with respect to the work piece so that the manipulator can accurately perform its function.
8,150,165	Visual Recognition		A method for visual recognition of an object in an electronic image includes extracting unique points of an object to be learned and/or a target object. The unique points are obtained by cross-correlating the image with a structure. Generally, the structure and/or the size of the structure may vary to detect extremum information associated with the learned object and/or target object. An icon corresponding to each of the unique points is extracted. The size of the icon corresponds to the scale of the unique point. After extraction of the various icons, an object becomes a collection of icons. Each of these icons is unrotated and normalized or resized to a constant size so it can be compared with other icons. One of the unique properties of these icons is their stability over scale and angle. Thus, this invention allows the recognition of an image(s) or object(s) from large number of trained images or objects very quickly.
8,308,151	Elevator Assembly for Robotic Positioning of a Workpiece		An elevator assembly includes a carrier, a first arm, and a second arm. Each arm has a primary portion pivotally connected to the carrier and a secondary portion pivotally connected to the primary portion. A first gear system interconnects the first arm and the second arm for synchronous rotation with respect to the carrier in opposite directions. A pair of second gear systems establish a geared relationship between the secondary portions of the arms and the carrier. A support member is connected to the secondary portions of the arms, wherein rotation of the primary portions of the arms with respect to the carrier drives the support member between a neutral position and at least a first extended position.
8,713,780	High Density Welding Subassembly Machine		An apparatus for welding motor vehicle body component subassemblies at a weld station. First and second pallets are arranged for reciprocal movement between a load/unload station and the weld station and the pallets are alternately moved from a load/unload station to the weld station while the other pallet is moved from the weld station to a load/unload station. Each pallet has a plurality of substations for receipt of component subassemblies and, while each pallet is at the load/unload station, the component subassembly at each substation is moved to the next successive substation and a further component is added to the moved component.
9,802,664	High Density Welding		Methods for welding motor vehicle body component subassemblies at a weld stations are disclosed. First and second pallets may be arranged for reciprocal movement between a load/unload station and the weld station and the pallets are alternately moved from a load/unload station to the weld station while the other pallet is moved from the weld station to a load/unload station. Each pallet may have a plurality of substations for receipt of component subassemblies and, while each pallet is at the load/unload station, the component subassembly at each substation is moved to the next successive substation and a further component is added to the moved component.
8,474,682	Single Geometry Palletized		A palletized framing system for a motor vehicle body assembly system in which the pallet with a body structure positioned thereon is positioned at the framing station on balls to establish the vertical Z dimension with the pallet free to float on the balls in longitudinal X and lateral Y dimensions, whereafter positioners carried by one of the gates of the framing station engage and lock onto the pallet to precisely position the pallet and the body structure at the framing station at X and Y dimensions corresponding to the precisely attainable X and Y positioning of the gate.
8,651,358	Single Geometry Palletized Framing System		A palletized framing system for a motor vehicle body assembly system in which the pallet with a body structure positioned thereon is positioned at the framing station on balls to establish the vertical Z dimension with the pallet free to float on the balls in longitudinal X and lateral Y dimensions, whereafter positioners carried by one of the gates of the framing station engage and lock onto the pallet to precisely position the pallet and the body structure at the framing station at X and Y dimensions corresponding to the precisely attainable X and Y positioning of the gate.
8,839,507	Remote Locking Apparatus for Securing a Vehicle Body to a Vehicle Body Support		A vehicle body positioning and locking devices for use in assembling a vehicle body positioned on a movable vehicle support positioned at a vehicle build station. The locking device includes a remote vehicle locking device for selectively securing and locking a vehicle body to a support pallet. The support pallet is accurately and precisely positioned at a build station through alignment and inserting engagement of locating pads in at least one four-way and at least one two-way receiver mounted to a build station foundation. A compliant body clamp design is included to provide a desired clamping force between the pallet and a vehicle body across a range of motion of the body clamp to accommodate vehicle build varrnnces.

Patent/Reg Number	Title	Illustration	Description
9,493,201	Vehicular Body Assembly Locking Apparatus and Method		A vehicle body positioning and locking devices for use in assembling a vehicle body positioned on a movable vehicle support positioned at a vehicle build station. The locking device includes a remote vehicle locking device for selectively securing and locking a vehicle body to a support pallet. The support pallet is accurately and precisely positioned at a build station through alignment and inserting engagement of locating pads in at least one four way and at least one two way receiver mounted to a build station foundation. A compliant body clamp design is included to provide a desired clamping force between the pallet and a vehicle body across a range of motion of the body clamp to accommodate vehicle build variances.
9,815,511	Vehicular Assembly Support Positioning Method		A method for positioning a vehicle assembly support device in a vehicle assembly station positioned along an assembly line. The method includes use of a plurality of locator pads selectively engaged with respective receiver sockets to position a vehicle support pallet in the X and Y coordinate directions. Vertical supports are used to position the vehicle support pallet in the Z coordinate direction. In one example, at least one receiver is a four-way positional receiver and at least one receiver is a two-way positional receiver. In another example, each receiver socket includes rollers which engage the respective locator pad to bias the vehicle support pallet towards the desired X and Y coordinate position.
8,818,531	Distributed Control System		Disclosed is a method for controlling a plurality of machines. The method includes identifying a first prerequisite operating condition for a first machine in the plurality of machines, the first machine having at least one control unit and configured to perform at least a first operation, obtaining at least one current operating condition corresponding to a second machine in the plurality of machines and if the at least one current operating condition meets the first prerequisite operating condition, performing the first operation.
9,821,473	Robotic Smart End Effector Tooling		A robotic end effector system and method having a plurality of end effectors which are selectively suitable for particular applications on a workpiece. The end effectors include a resident controller adapted to execute tasks specific to the end effector and are rapidly attachable and removable from the robot for easy change over to different workpieces.
9,151,689	Flexible Leak Test Apparatus and Method		A flexible leak test apparatus and method for leak testing a variety of workpieces having various multiple configurations with at least one internal cavity and at least one aperture leading therefrom. The flexible leak test apparatus and method provide a plurality of leak test fixtures adaptable to receive the workpieces. Each leak test fixture has a bottom portion and a top portion that engage one another when the workpieces are loaded in the bottom portion of the leak test fixture. The leak test fixtures are shuttled in and out of the workstation, and a manipulator loads and unloads the workpieces into and out of the bottom portion of the leak test fixtures. The leak test fixtures seal the apertures in the workpieces so that the workpieces can be leak tested by pressurizing the internal cavity of the workpiece.
8,789,269	Modular Manufacturing Facility and Method		A modular manufacturing facility and method of construction includes a plurality of service and equipment modules which are readily sized and oriented to be packaged, shipped to a desired location, assembled and connected to local resources to form a fully operational assembly or build facility substantially or wholly independent of any resident building structure at the selected site.
8,869,370	Sequenced Part Delivery System		A system and method for sequencing component part delivery for use in assembling vehicle bodies arranged in a substantially random assembly sequence. The system and method includes a plurality of kit carts that are loaded or stocked with vehicle specific parts in a sequence or staging area of an assembly facility. The vehicle specific stocked carts are arranged and positioned to a coordinated vehicle to assemble the vehicle using the kit carts that move along in sequence with the vehicle as the vehicle is assembled along an assembly line. As the carts are depleted of parts, the carts are returned for restocking and assigned to a subsequent vehicle.
9,513,625	Integrated Vehicle Part Delivery and Build System		A device and method for assembling parts, products or machines in a random build order that integrates or combines the delivery of loose components to be assembled on a carriage that itself supports the device being assembled along an assembly line path of travel. The loose parts onboard the carriage that also supports the device being progressively assembled substantially improves the logistics in an assembly plant and efficiency in building the part, product or device, for example a vehicle sheet metal body.
9,168,547	Thermal Metal Spraying Apparatus		A thermal metal spraying apparatus for use with a thermal metal spraying torch for applying a metal coating to a workpiece through a torch spraying nozzle having a spraying orifice. The thermal metal spraying apparatus provides a substantially tubular shroud having a first end and a second end adaptable to concentrically receive the torch spraying nozzle. The shroud has an opening at the second end, wherein the opening is selectably alignable with the spraying orifice. A drive mechanism is connected to the shroud and is operable to translate the shroud between a first position, wherein the opening at the second end is not aligned with the spraying orifice, thereby preventing the spraying of the metal coating on the workpiece, and a second position, wherein the opening at the second end is aligned with the spraying orifice permitting the spraying of the metal coating toward the workpiece.

Patent/Reg Number	Title	Illustration	Description
10,052,744	Fixture for Supporting a Workpiece		A fixture for holding a workpiece includes clamps configured to engage tie rods secured to the workpiece, locating pins configured to engage a corresponding pin secured to the workpiece, pads, and actuators configured to move clamps for alternately drawing the workpiece into contact with the pads and disengaging the tie rod from the clamp such that the fixture assembly can release the workpiece.
9,032,609	Direct Vehicle Body Locking Sensor Apparatus and Method		Disclosed herein is a sensing device for use in providing positive feedback of the position of a vehicle body securing device used to selectively secure a vehicle body to a vehicle body support movable along a path of travel. A vehicle body securing device is selectively movable between a locked position and an unlocked position. An indicator is connected to the securing device and is reciprocally movable to and from a target area when the securing device is in one of the locked position and the unlocked position. A sensor has a field of view selectively alignable with the target area. The sensor is operable to detect when the indicator is positioned at the target area to provide a positive indication of the position of the securing device.
8,950,065	Weld Gun Part Clamp Device and Method		A combination component handling and connecting device connectable to a multi-axis robot for use in moving and connecting components and subassemblies includes a housing and an actuator fixedly connected to the housing. The actuator includes an actuating link movable from a first position to a second position. Connected to the actuating link is an end effector for concurrent movement with the actuating link. The component handling and connecting device includes a clamp having a first jaw and a second jaw. The second jaw is connected to the actuating link for selectively moving the second jaw toward the first jaw operative to engage a component.
9,796,041	Method for Component Handling and Connecting of Components		A combination component handling and connecting device connectable to a multi-axis robot for use in moving and connecting components and subassemblies includes a housing and an actuator fixedly connected to the housing. The actuator includes an actuating link movable from a first position to a second position. Connected to the actuating link is an end effector for concurrent movement with the actuating link. The component handling and connecting device includes a clamp having a first jaw and a second jaw. The second jaw is connected to the actuating link for selectively moving the second jaw toward the first jaw operative to engage a component.
10,384,298	Weld Gun Part Clamp Device and Method		A combination component handling and connecting device connectable to a multi-axis robot for use in moving and connecting components and subassemblies includes a housing and an actuator fixedly connected to the housing. The actuator includes an actuating link movable from a first position to a second position. Connected to the actuating link is an end effector for concurrent movement with the actuating link. The component handling and connecting device includes a clamp having a first jaw and a second jaw. The second jaw is connected to the actuating link for selectively moving the second jaw toward the first jaw operative to engage a component.
9,528,556	Multiple Natural Frequency Coupling Apparatus		A multiple natural frequency coupling apparatus for connecting a rotatable driving member to a rotatable driven member of a drive line. The coupling apparatus of the present invention provides a substantially cylindrical housing having a longitudinal axis with a substantially cylindrical outer shaft coaxially aligned with and connected to the housing. A substantially cylindrical inner shaft is coaxially aligned with the outer shaft and the housing. A substantially cylindrical chuck housing is coaxially aligned with the housing, the outer shaft, and the inner shaft wherein the fluid chuck housing is connected to the inner shaft. A substantially cylindrical collapsible sleeve is coaxially aligned with and between the fluid chuck housing and the outer shaft, wherein the collapsible sleeve may move between a non-actuated position, wherein the collapsible sleeve does not engage the outer shaft thereby providing the coupling apparatus with a first torsional stiffness corresponding to a first natural frequency, and an actuated position, wherein the collapsible sleeve engages the outer shaft thereby providing the coupling apparatus with a second torsional stiffness corresponding to a second natural frequency.
9,581,983	Methods For Using An Automated Guided Cart		An automated guided cart (AGC) that is configured to travel along a cart path according to generally non-precision movements is implemented to support a build process requiring precise positioning of vehicle build devices. In an example of a method of use, a vehicle build device for the build process is engaged with the AGC. When the AGC travels proximate a build operation area, the AGC can be secured in a dimensionally fixed position, with the result that both the AGC and a vehicle build device engaged with the AGC are located in precise positions. Based on the precise location of the vehicle build device, the vehicle build device can be interfaced with robots or other automated equipment according to preprogrammed and/or precise movements to carry out a build process.
9,808,857	Continuous Fastener Feeding Apparatus and Method		Methods and apparatuses for continuous fastener feeding for sequentially delivering single fasteners to a fastener installation device are disclosed. In one embodiment the apparatus includes a first fastener reel for supporting a first fastener tape securing a plurality of fasteners and a second fastener reel for supporting a second fastener tape for securing a plurality of fasteners. A fastener tape joining device positioned downstream of the first and second fastener reels receives the respective first and the second fastener tapes and selectively engage the first and second fastener tapes when one of the fastener tapes becomes depleted of fasteners.

Patent/Reg Number	Title	Illustration	Description
9,962,758	Continuous Fastener Feeding Apparatus and Method		Methods and apparatuses for continuous fastener feeding for sequentially delivering single fasteners to a fastener installation device are disclosed. In one embodiment the apparatus includes a first fastener reel for supporting a first fastener tape securing a plurality of fasteners and a second fastener reel for supporting a second fastener tape for securing a plurality of fasteners. A fastener tape joining device positioned downstream of the first and second fastener reels receives the respective first and the second fastener tapes and selectively engage the first and second fastener tapes when one of the fastener tapes becomes depleted of fasteners.
9,410,895	Process And Apparatus For Inspecting A High Volume Material Jointing Operation		A method of sequentially performing a plurality of jointing operations includes positioning an automated device to form a mechanical joint into a workpiece and forming a mechanical joint into the workpiece. Once the mechanical joint is formed, the workpiece is scanned to generate data indicating the surface geometry of the workpiece at a location including the mechanical joint. One or more geometric features of the surface geometry are identified, and if the identified geometric features are within respective predetermined specification thresholds, the automated device is repositioned to form a subsequent mechanical joint into the workpiece.
10,384,873	Inverted Carrier Lift Device System and Method		An inverted carrier lift and method is disclosed. The inverted carrier lift includes a trolley movable along an overhead conveyor and a carrier for supporting a workpiece to undergo an assembly or manufacturing process. The carrier is movable relative to the trolley from a raised position to a lowered position by a motor mounted engaged with a lifting mechanism onboard the trolley. On rotation of the motor, the carrier and supported workpiece is lowered or raised to position the workpiece in the workstation for processing. The workpiece may be disengaged by the carrier for support of the workpiece by one of many different fixtures depending on the processing. Following processing, the workpiece is re-engaged by the carrier, moved to a raised position and the trolley is transferred to a subsequent workstation.
10,131,388	Modular Vehicle Assembly System and Method		A modular vehicle assembly system and methods for increased flexibility and adaptability of a high volume assembly facility which builds several vehicle models. In one example, the invention includes modular assembly equipment (AE) support pallets which are shipped to vendors for installation of selected AE equipment devices that are specific to a predetermined assembly operation and then validation tested prior to shipment. The modular AE pallets and AE devices are quickly installed and easily removable for maintenance or replacement. In other examples, modular AE support platforms and safety fencing are used to support ground level assembly operation and safer working environment.
10,286,549	Adaptable End Effector and Method		An adaptable end effector useful to accommodate a wide variety of components, component geometries and variations in component geometries. In one example, the end effector includes a movable arm and at least three fingers each having a gripping tool for engagement of the component with variable and/or programmable holding force preventing relative movement.