US 20040150156A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2004/0150156 A1

Fromherz et al. (43) Pub. Date: Aug. 5, 2004

(54) **FRAMELESS MEDIA PATH MODULES**

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(21) Appl. No.: **10/357,761**

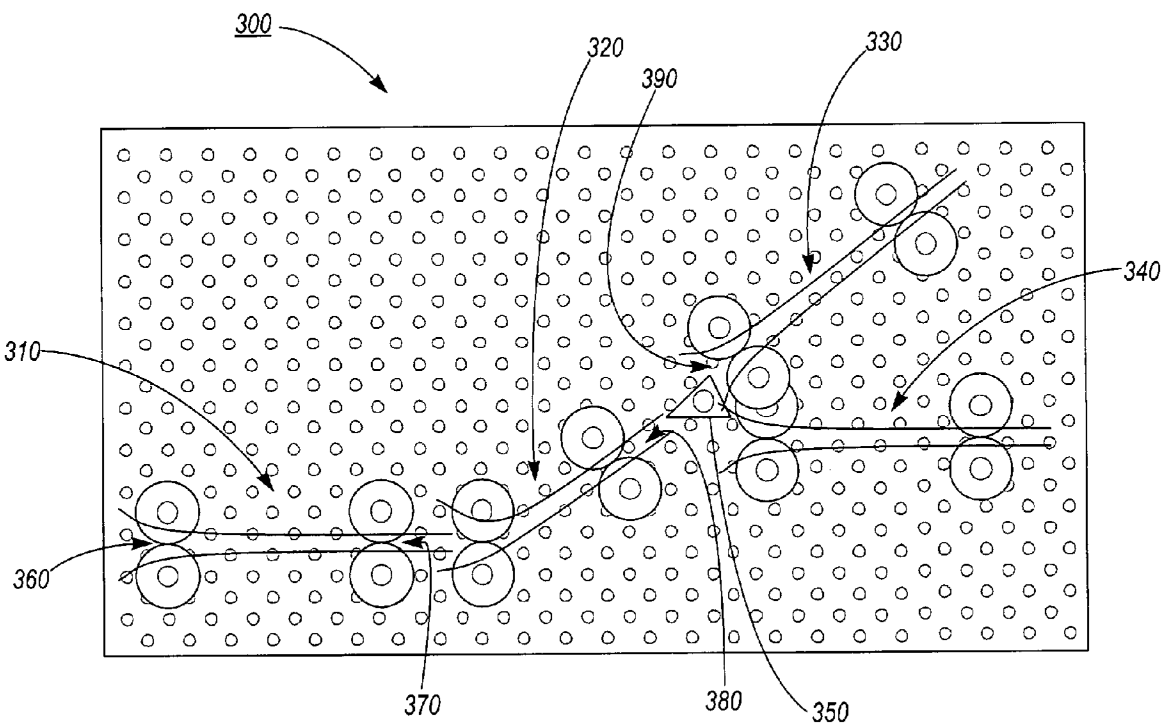
(22) Filed: **Feb. 4, 2003**

**Publication Classification**

(51) Int. Cl.[7] ........ B65H 5/02
(52) U.S. Cl. ........ 271/272

(57) **ABSTRACT**

A frameless media path module is provided for a media processing system feeding media streams through a media path structured for serial or parallel flows. The frameless media path module includes a plurality of media guides and not less than two media transport nips operated by at least one actuator. Means is included for attaching the frameless media path module to a supporting structure. Media state sensing electronics detect media edge or relative motion and intermodule electrical communication capability is provided.



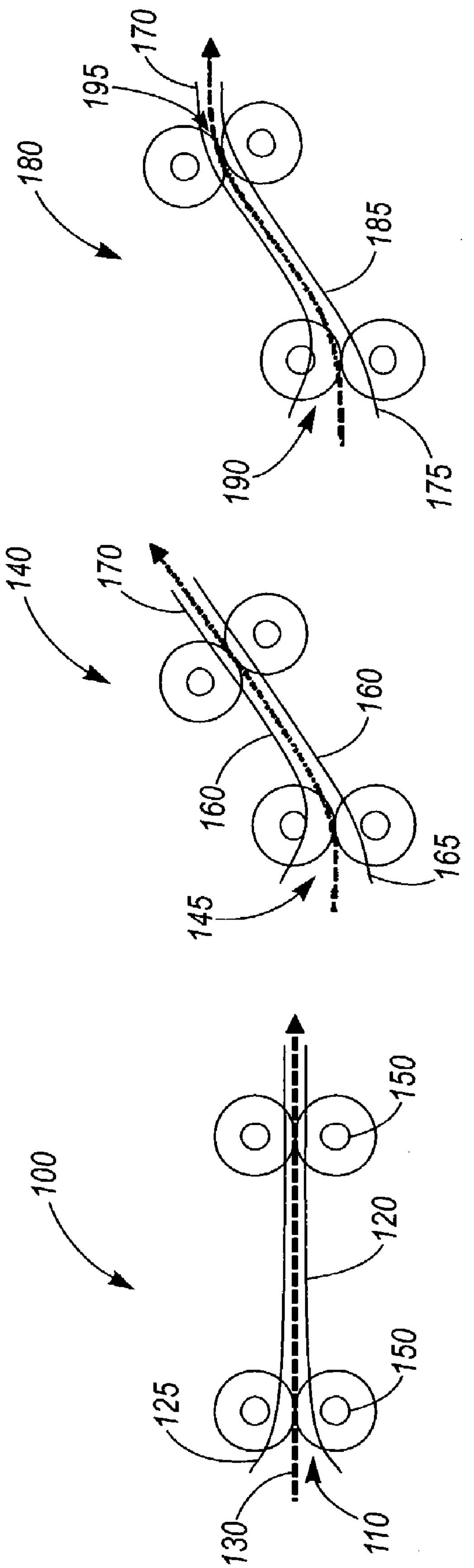

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FIG. 1

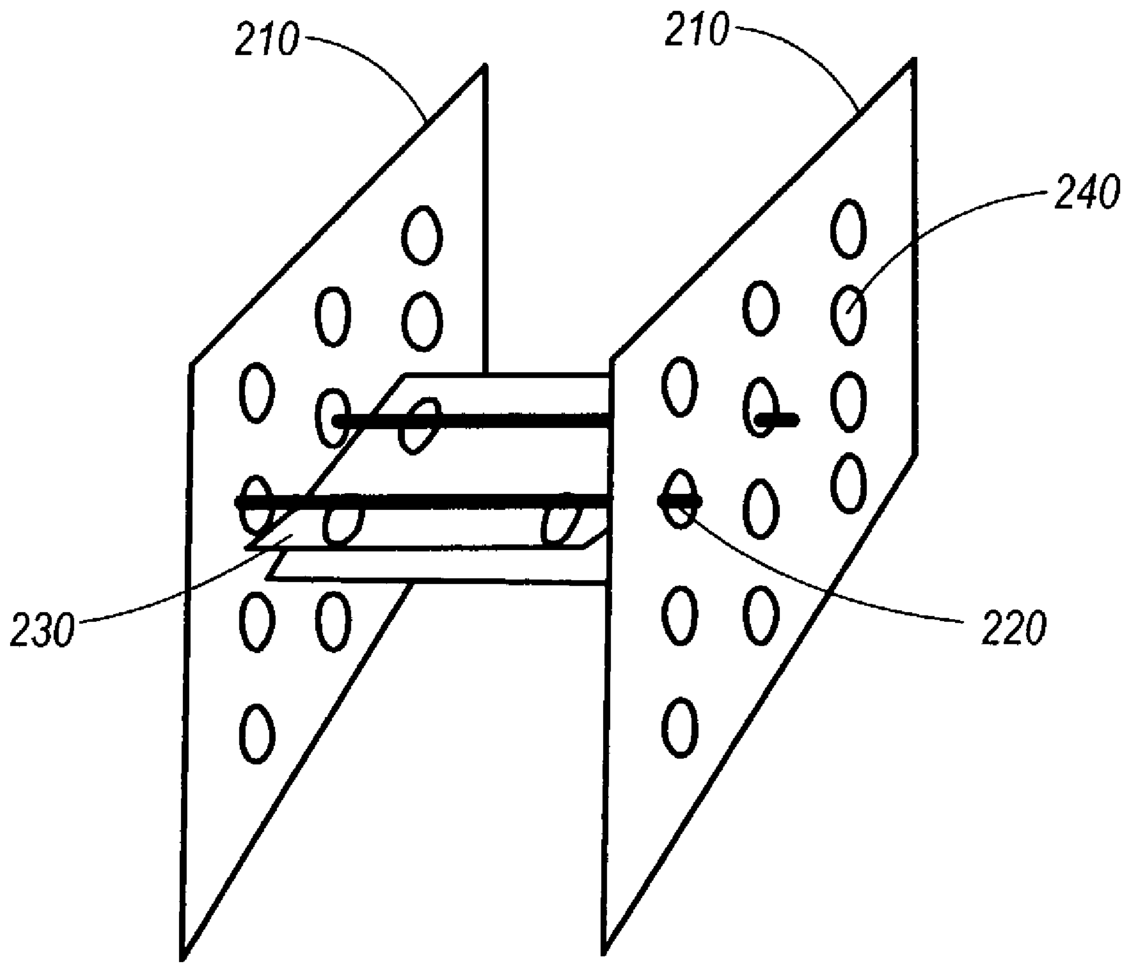


FIG. 2

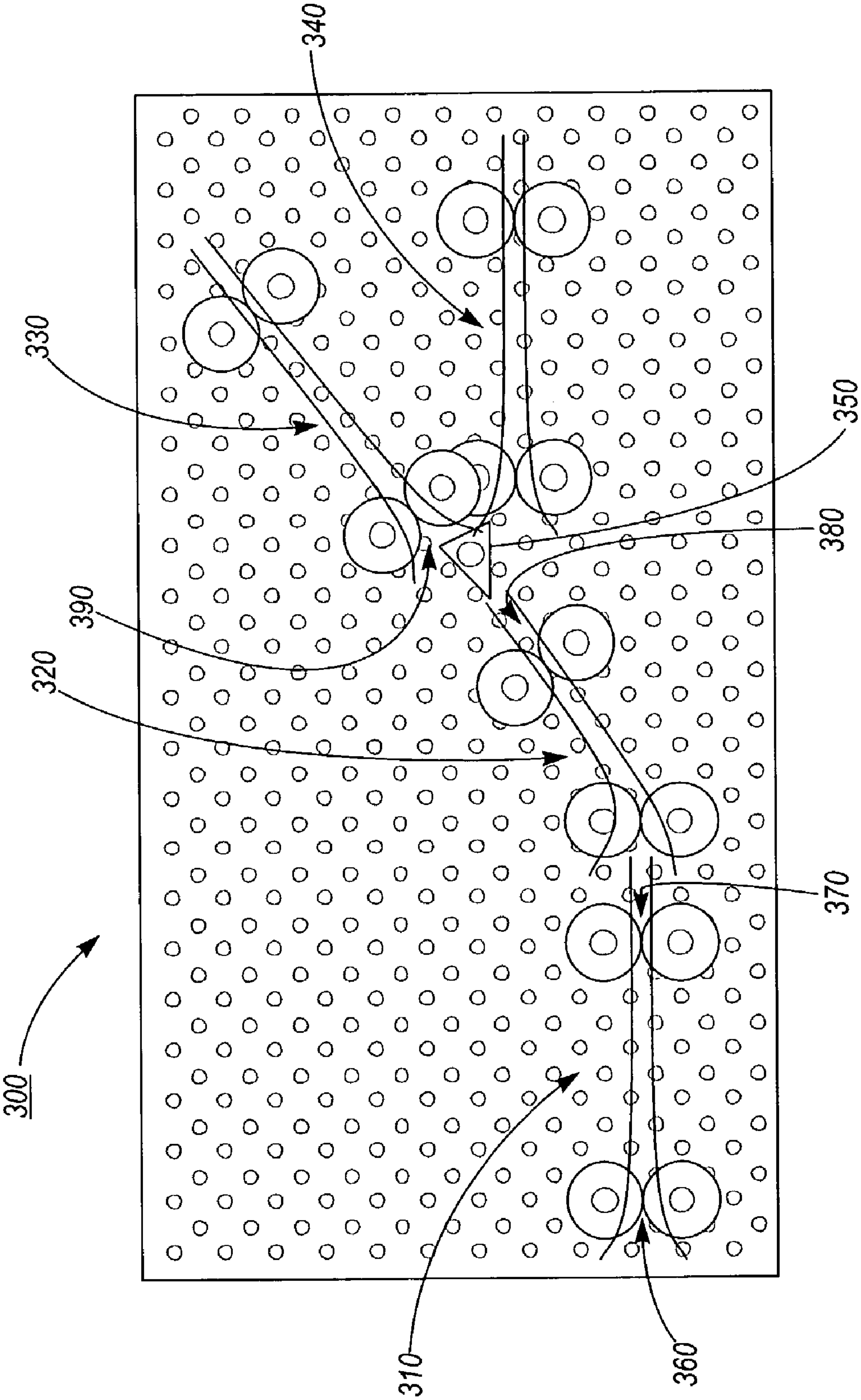


FIG. 3

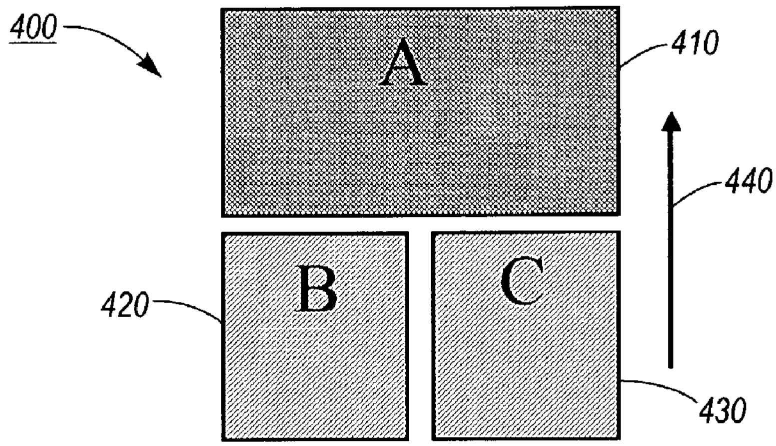


FIG. 4

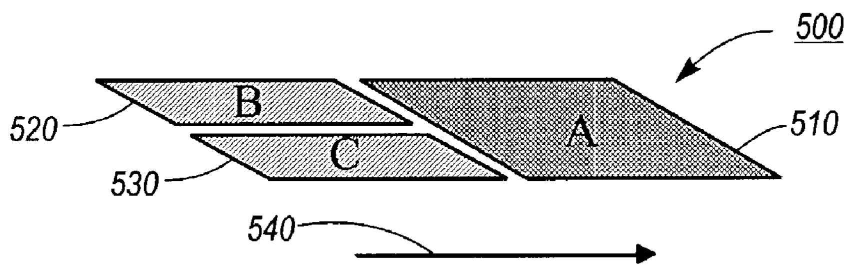


FIG. 5

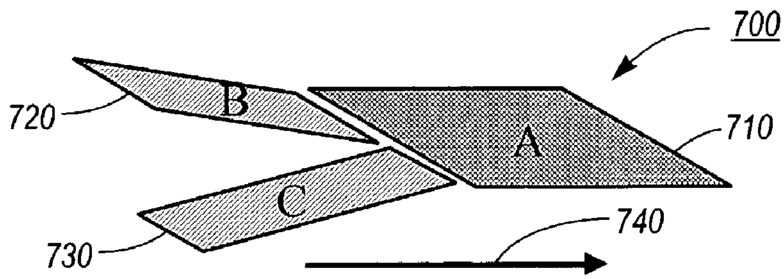


FIG. 7

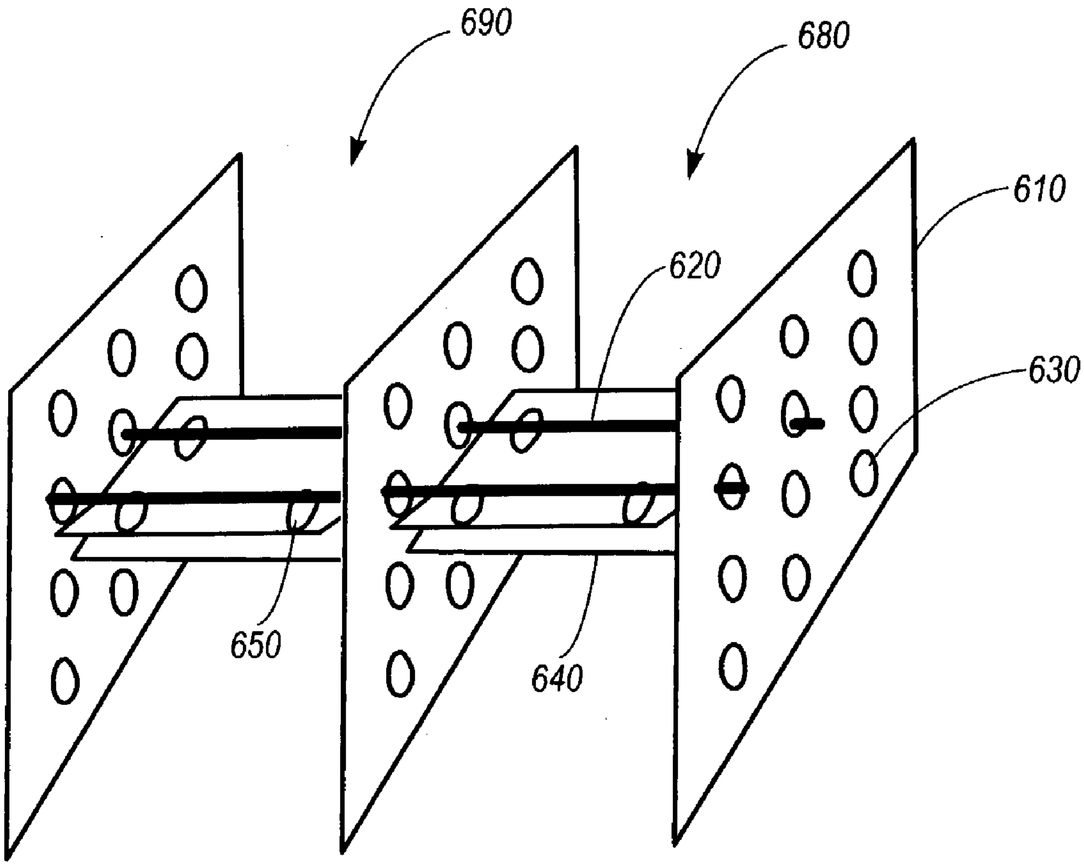


FIG. 6

# FRAMELESS MEDIA PATH MODULES

## CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The following copending applications, Attorney Docket Number D/A3012, U.S. application Ser. No. ______, filed Feb. 4, 2003, titled "Media Path Modules", is assigned to the same assignee of the present application. The entire disclosure of this copending application is totally incorporated herein by reference in its entirety.

## INCORPORATION BY REFERENCE

[0002] The following U.S. patents are fully incorporated herein by reference: U.S. Pat. No. 5,467,975 to Hadimioglu et al. ("Apparatus and Method for Moving a Substrate"); and U.S. Pat. No. 6,059,284 to Wolf et al. ("Process, Lateral and Skew Sheet Positioning Apparatus and Method").

## BACKGROUND OF THE INVENTION

[0003] This invention relates generally to media transport systems, and more particularly to modular, reconfigurable media path modules within such a transport system.

[0004] Paper transport systems within printing systems are generally constructed from custom designed units, usually consisting of heavy frames supporting pinch rollers driven by one or a few motors. One such system is shown in U.S. Pat. No. 6,322,069 to Krucinski et al., which utilizes a plurality of copy sheet drives, pinch rollers, and belts to transport paper through the printer system. Another approach is taught by U.S. Pat. No. 5,303,017 to Smith, which is directed to a system for avoiding inter-set printing delays with on-line job set compiling or finishing. Smith accomplishes this through the use of sheet feeders and diverter chutes with reversible sheet feeders, also utilizing pinch rollers driven by motors. However, because prior art transport systems are custom designed to meet the differing needs of specific printing systems, field reconfigurability and programmable reconfigurability are not possible.

[0005] It is an object of this invention to provide frameless standard modules, consisting of standard subunits, which can be linked physically, electrically and electronically by attachment to an external frame, and from which any path for transporting flexible media could be constructed.

## SUMMARY OF THE INVENTION

[0006] Briefly stated, and in accordance with one aspect of the present invention, a frameless media path module is provided for a media processing system feeding media streams through a media path structured for serial or parallel flows. The frameless media path module includes a plurality of media guides and not less than two media transport nips operated by at least one actuator. Means is included for attaching the frameless media path module to a supporting structure. Media state sensing electronics detect media edge or relative motion and intermodule electrical communication capability is provided.

[0007] In accordance with another aspect of the invention, a reconfigurable media path assembly is provided for a media processing system feeding media streams through a media path structured for serial or parallel flows. The reconfigurable media path assembly includes not less than one frameless media path module having a plurality of media guides, not less than two media transport nips, module attachment means, at least one actuator, intermodule electrical communication means, and media state sensing electronics. The frameless media path modules are attached to a support assembly.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The foregoing and other features of the instant invention will be apparent and easily understood from a further reading of the specification, claims and by reference to the accompanying drawings in which:

[0009] **FIG. 1** illustrates transport module configurations formed from components according to the subject invention;

[0010] **FIG. 2** is a perspective view of one embodiment of a transport module assembled on a support panel according to the subject invention;

[0011] **FIG. 3** illustrates an configuration of modules to form a reconfigurable media path;

[0012] **FIG. 4** illustrates a plan view of a configuration of modules within a double-wide framework;

[0013] **FIG. 5** is an oblique view of the embodiment according to **FIG. 5**;

[0014] **FIG. 6** is a perspective view of the embodiment of **FIG. 5** showing transport modules assembled on support panels according to the subject invention;

[0015] **FIG. 7** is an oblique view of the embodiment according to **FIG. 5**, in which media is directed into or out of the media plane.

## DETAILED DESCRIPTION OF THE INVENTION

[0016] Paper transport systems, constructed from custom designed units generally consisting of heavy frames supporting pinch rollers driven by one or a few motors, are utilized extensively in industry, but have limitations in regard to part reusability and reconfigurability. Standard paper path modules from which any paper path could be constructed would enable shorter time-to-market, lower cost through economies of scale, high part reusability, field reconfigurability, and programmable reconfigurability. The media path modules disclosed herein consist of an integrated, flexible sheet transport and guide assembly with motor driven drive nip units, paper convergence guide units, sheet edge and/or relative motion detection units, and power/computation/communication units. The modules are fixed in place to an external frame to form a modular system which is physically strong and electrically bussed.

[0017] Turning to **FIG. 1**, there is illustrated exemplary embodiments **100**, **140**, and **180** of generic transport modules for linearly translating or turning media. Such units can be used to merge paper streams or pass media along forward or backward in the process directions. Module **100** consists of flexible media guides **120** with integrated media transport nips **110**, media inlet guides **125**, and drive motors **150** (shown oversized) configured to transport media in a desired path, in this example generally horizontal in direction. The modules are essentially uniform along their length with the motor drives mounted at the two ends of the module. Various types of sheet guides are contemplated by the disclosure herein, for example solid, perforated, or others known in the art. The motors may be much smaller than shown in **FIG. 1**, and thus modules can be more closely configured than would appear from the figure. Additionally, the modules can be driven using separate motors or, in less general applications, can be chain driven by a single motor (e.g. for a module in which media only enter from a fixed side).

[**0018**] For the purposes of clarity, a cylindrical nip is illustrated as the transport mechanism for this embodiment. Cylindrical nips are pinch rollers which contact the media from both sides along a line. One of the cylinders is driven rotationally about its axis and the other is an idler which supports or provides the normal pinching force. It should be noted that other actuation means to provide tangential media forces can be used instead. An example of one such alternate means of actuation is a spherical nip actuator, which contacts the media in only a small area and is in principle capable of driving the media tangentially in an arbitrary direction, as is described in U.S. Pat. No. 6,059,284 to Wolf et al. ("Process, Lateral and Skew Sheet Positioning Apparatus and Method") incorporated herein by reference in its entirety. Another example of an alternate means of actuation is a piezoelectrically driven brush or brushes to move the media in a desired direction, as taught by U.S. Pat. No. 5,467,975 to Hadimioglu et al. ("Apparatus and Method for Moving a Substrate") incorporated herein by reference in its entirety.

[**0019**] These basic elements may alternately be configured as shown in configurations **140** and **180**, which also include media inlet guides **165** and media exit guides **170**. In configuration **140** media inlet guides **165**, flexible media guides **160**, and transport nip **145** are configured to impart an angular directional change in the media path. In configuration **180**, flexible media guides **185**, media inlet guides **175**, media outlet guides **170**, and media transport nips **190** and **195** impart dual angular directional changes in the media path. The modules include media edge sensors and driven transport nips with media inlet guides. All drive and control electronics as well as communication bus drivers are mounted onto the guide using any of many methods known in the art, for example flexible printed circuit board technology. All intermodule electrical signals for power and communication are passed to the modules by connectors which connect either with other modules or with the external frame.

[**0020**] The term module here refers to an assembly of guides, rollers, motors, sensors, and optional computational and communication components. Different module types with different properties may be provided for different purposes, e.g., transport modules, gate modules with additional switch and motor, registration modules, etc. Turning now to **FIG. 2**, one embodiment of a module assembly does not require a rigid frame for the transport modules themselves, but instead consists of an external frame providing support for individual transport modules. In this example embodiment, the frame is formed from two parallel panels **210** having a predetermined hole pattern. Although in this example embodiment holes **240** in the hole pattern are shown as being circular, it will readily be appreciated that the hole pattern could assume any of numerous geometric shapes or, alternatively, a slot pattern could be utilized. Rods **220** are attached to parallel panels **210** at desired opening locations by any methods known in the art. Although rods **220** are cylindrical in shape as illustrated in this embodiment, they may be fabricated in various geometric shapes, for example they may have square or rectangular cross-sections. The transport module **230** is then attached at either the module top or bottom to rods **220**. By being attached on only one side to rods **220**, the other side of transport module **230** may be hinged to permit opening of the module for clearance of a media blockage. Frame panels **210** and rods **220** may be fabricated from metals and plastics known in the art.

[**0021**] Alternative means to assemble a frame to hold the media modules are possible. For example, instead of parallel panels, an open structure of beams may be assembled to form a rigid frame as in an open frame bridge. As another alternative, a solid housing of fixed or variable size could serve a similar purpose. In another embodiment, the transport modules may be attached directly to a rigid frame, rather than being supported by rods. This approach, although it may limit field reconfigurability of the transport system, would still provide flexibility in assembly in a manufacturing environment. Interlocking mechanisms to connect modules to the frame may be selected from many alternative means known to the art. All drive and control electronics as well as communication bus drivers are mounted on the modules or within the frame. All intermodule electrical signals (power and communication) are passed through by connectors, either with other modules or via the frame, which mate as part of the operation of connecting modules to the frame and to other modules.

[**0022**] **FIG. 3** illustrates an example of a reconfigurable media path **300** configured from a plurality of standard modules. In example embodiment **300** the media paths can be retrograde as well as forward transporting and parallel flows can be enabled. Here modules **310**, **320**, **330**, and **340** are attached to panel **360** in such a way that media received by module **310** may be transported by module **320** to gate module **350**, which provides the capability for splitting a media path and creating parallel media paths. In this example, media may flow past gate **350** either to module **330** or module **340**. The spacing and size of the modules are determined by several aspects of the sheets to be transported. For example, the spacing between nips **360** and **370** must be less than the shortest media length in the process direction. Similarly, the spacing between nips **380** and **390** also must be less than the shortest media length in the process direction. Media stock stiffness provides another constraint, in that the radius of curvature in turns, such as at the transition from module **310** to module **320**, cannot be too small to accommodate the stiffest media that may move through the media path. A typical radius in xerographic printer applications is approximately five centimeters. For constraints typical of current xerographic usage, the spacing between nips would be approximately ten centimeters, with a five centimeter radius of curvature in turning operations.

[**0023**] The embodiments described with respect to **FIG. 2** hereinabove enable the ability to construct a double-wide frame supporting both large and smaller transport path assemblies side by side on the same rod. This enables provision for two parallel media paths in the same frame, as illustrated in **FIG. 4** in a top view to show the arrangement of transport path assemblies. Here single frame **400** supports transport path assemblies **410**, **420**, and **430**, with media moving in process direction **440**. In this example embodiment, media is being transported from separate parallel paths **420** and **430** to a single output path **410**. Using the xerographic process as an example, paths **420** and **430** may be transporting paper from two different print engines to a single finisher served by path **410**.

[**0024**] This embodiment is further illustrated in **FIG. 5**, in an oblique view. Because paths **520** and **530** are parallel and in the same plane, module-supporting rods (not shown in this figure, but as rods **620** in **FIG. 6**) may extend the entire width of both transport assemblies **520** and **530** to support transport modules mounted internally in those transport path assemblies. In this embodiment media moves along process path direction **540**, with transported media from transport path assemblies **520** and **530** being received by transport path assembly **510**. This embodiment is illustrated in perspective in **FIG. 6**, in which module support rods **620** extend the entire width of two transport assemblies **680** and **690**. Attachment means **650** secure transport modules **640** to rods **620**. In this example embodiment, the frame is formed from parallel panels **610** having a predetermined hole pattern. Although in this example embodiment the hole pattern is shown as being circular, it will readily be appreciated that the hole pattern could assume any of numerous geometric shapes or, alternatively, a slot pattern could be utilized. Rods **620** are attached to parallel panels **610** at desired opening locations by any methods known in the art. Although rods **620** are cylindrical in shape as illustrated in this embodiment, they may be fabricated in various geometric shapes, for example, they may have square or rectangular cross-sections. The transport modules **640** are attached at either the module top or bottom to rods **620**. By being attached on only one side to rods **620**, the other side of transport modules **640** may be hinged to permit opening of the module for clearance of a media blockage. Frame panels **610** and rods **620** may be fabricated from metals and/or plastics known in the art.

[**0025**] Alternative means to assemble a double-wide frame to hold the media modules are possible. For example, instead of parallel panels, an open structure of beams may be assembled to form a rigid frame as in an open frame bridge. As another alternative, a solid housing of fixed or variable size could serve a similar purpose. In another embodiment, the transport modules may be attached directly to a rigid double-wide frame, rather than being supported by rods. This approach, although it may limit field reconfigurability of the transport system, would still provide flexibility in assembly in a manufacturing environment. Interlocking mechanisms to connect modules to the frame may be selected from many alternative means known to the art. All drive and control electronics as well as communication bus drivers are mounted on the modules or within the frame. All intermodule electrical signals (power and communication) are passed through by connectors, either with other modules or via the frame, which mate as part of the operation of connecting modules to the frame and to other modules.

[**0026**] Another possible arrangement of transport path assemblies is illustrated in **FIG. 7**, in which parallel paths in differing planes provide for the joining of transport paths from transport path assemblies **720** and **730** into transport path assembly **710**, again moving in process direction **740**. This arrangement provides for a gate module at point **750** which is capable of moving media in a lateral direction (left to right or right to left) such that media can be moved along one of two alternate route in process direction **740**. Similarly, by moving in the reverse process direction, two paths can be merged into a single path. This enables the connection of not only transport paths that are stacked on top of one another, but also paths that are laid out side by side in a double-wide frame.

[**0027**] Various means may be utilized to assemble a double-wide frame to hold the media modules in the double-wide embodiments contemplated in **FIG. 7**. For example, parallel panels, such as described with reference to **FIG. 6**, could shape the double-wide frame, or an open structure of beams may be assembled to form a rigid frame as in an open frame bridge. As another alternative, a solid housing of fixed or variable size could serve a similar purpose. In another embodiment, the transport modules may be attached directly to a rigid double-wide frame, rather than being supported by rods. This approach, although it may limit field reconfigurability of the transport system, would still provide flexibility in assembly in a manufacturing environment. Interlocking mechanisms to connect modules to the frame may be selected from many alternative means known to the art. All drive and control electronics as well as communication bus drivers are mounted on the modules or within the frame. All intermodule electrical signals (power and communication) are passed through by connectors, either with other modules or via the frame, which mate as part of the operation of connecting modules to the frame and to other modules.

[**0028**] While the present invention has been illustrated and described with reference to specific embodiments, further modification and improvements will occur to those skilled in the art. For example, the modules may utilize separately driven nips and the nips can be independent in the cross-process direction as well, to permit deskewing and other operations requiring more than one degree of freedom. Additionally, other types of sheet state sensors, such as relative motion detectors, can be used in place of or in addition to sheet edge detectors. It is to be understood, therefore, that this invention is not limited to the particular forms illustrated and that it is intended in the appended claims to embrace all alternatives, modifications, and variations which do not depart from the spirit and scope of this invention.

What is claimed:

**1**. For a media processing system feeding media streams through a media path structured for serial or parallel flows, a frameless media path module comprising:

a plurality of media guides;

not less than two media transport nips;

module attachment means;

actuation means;

intermodule electrical communication means; and

media state sensing electronics.

**2**. The frameless media path module according to claim 1, wherein said media transport nips comprise cylindrical nips.

**3**. The frameless media path module according to claim 1, wherein said media transport nips comprise spherical nips.

**4**. The frameless media path module according to claim 1, wherein said media transport nips comprise piezoelectrically driven brushes.

**5**. The frameless media path module according to claim 1, further comprising computational electronics.

**6**. The frameless media path module according to claim 1, wherein said not less than two media transport nips are spaced a distance apart, said distance being less than the shortest media length in the process direction.

**7**. The frameless media path module according to claim 1, wherein said actuation means comprises not less than one motor drive unit.

**8**. The frameless media path module according to claim 1, wherein said actuation means comprises separate motor drive units for each of said not less than two media transport nips.

**9**. The frameless media path module according to claim 8, wherein said motor drive units drive said not less than two media transport nips independently in the process direction.

**10**. The frameless media path module according to claim 8, wherein said motor drive units drive said not less than two media transport nips independently in the cross-process direction.

**11**. The frameless media path module according to claim 1, further comprising media state sensors.

**12**. The frameless media path module according to claim 11, wherein said media state sensors comprise media edge sensors.

**13**. The frameless media path module according to claim 11, wherein said media state sensors comprise relative motion sensors.

**14**. The frameless media path module according to claim 1, further comprising not less than two media inlet guides.

**15**. The frameless media path module according to claim 1, further comprising not less than two media outlet guides.

**16**. For a media processing system feeding media streams through a media path structured for serial or parallel flows, a reconfigurable media path assembly comprising:

not less than one frameless media path module including a plurality of media guides, not less than two media transport nips, module attachment means, actuation means, intermodule electrical communication means, and media state sensing electronics; and

a support assembly.

**17**. The reconfigurable media path assembly according to claim 16, wherein said support assembly comprises:

not less than one external frame;

frameless media path module supporting means; and

frameless media path module attachment means.

**18**. The support assembly according to claim 17, wherein said not less than one external frame comprises not less than two parallel panels.

**19**. The support assembly according to claim 17, wherein said not less than one external frame comprises an open structure.

**20**. The support assembly according to claim 17, wherein said not less than one external frame comprises a solid housing.

**21**. The support assembly according to claim 17, wherein said frameless media path module supporting means comprises not less than two supporting rods.

**22**. The support assembly according to claim 21, wherein said supporting rods have a cross-section, said cross-section being geometric in shape.

**23**. The support assembly according to claim 17, wherein said frameless media path module attachment means is secured to not more than one surface of the frameless media path module.

**24**. The support assembly according to claim 23, wherein said unsecured surface of the frameless media path module is configured to permit access to an interior region of the frameless media path module.

**25**. The reconfigurable media path assembly according to claim 16, further comprising a gate module.

**26**. The reconfigurable media path assembly according to claim 16, wherein the reconfigurable media path assembly comprises a plurality of frameless media path modules.

**27**. The reconfigurable media path assembly according to claim 16, wherein not less than two reconfigurable media path assemblies are configured to form parallel media transport paths in the same transport plane.

**28**. The reconfigurable media path assembly according to claim 16, wherein not less than two reconfigurable media path assemblies are configured to form parallel media transport paths in different transport planes.

**29**. The reconfigurable media path assembly according to claim 16, wherein not less than three reconfigurable media path assemblies are configured to form not less than two parallel media transport paths which are joined to a single media transport path in the process direction.

**30**. The reconfigurable media path assembly according to claim 16, wherein not less than three reconfigurable media path assemblies are configured to form a single media transport path which is split into two parallel media transport paths in the process direction.

* * * * *