United States Patent

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[54] **SHUTTLE ASSEMBLY**
6 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **271/54,** 271/85
[51] **Int. Cl.** **B65h 5/04**
[50] **Field of Search** 271/85, 79, 54, 8; 198/33

[56] **References Cited**

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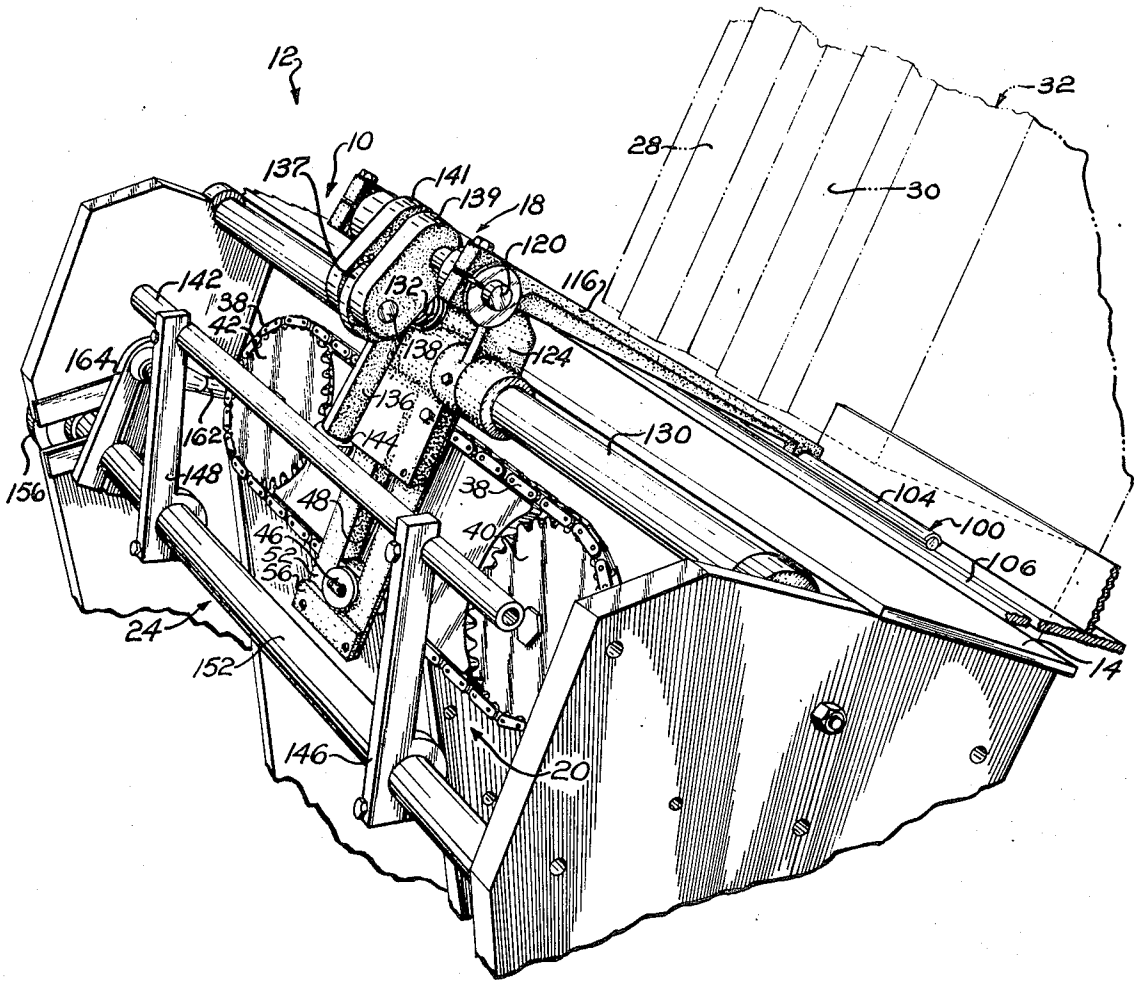
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ABSTRACT: Disclosed herein is a shuttle assembly having a clamp assembly for gripping sheet material and a chain drive mechanism for reciprocating the clamp assembly. The chain drive mechanism accelerates the clamp assembly to an operating speed during initial portions of forward and reverse strokes of the clamp assembly, maintains the operating speed during major portions of the strokes and decelerates the clamp assembly during end portions of the strokes.



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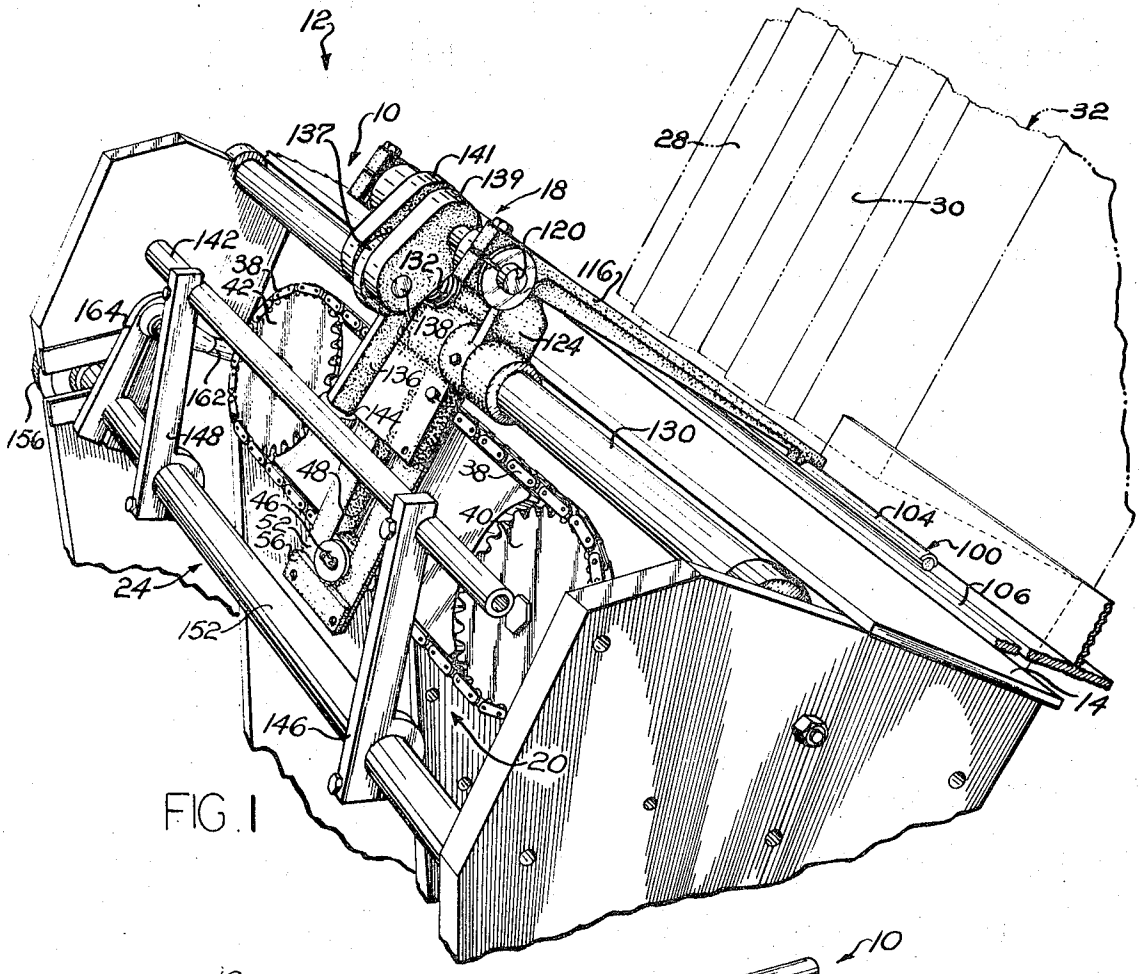


FIG. 1

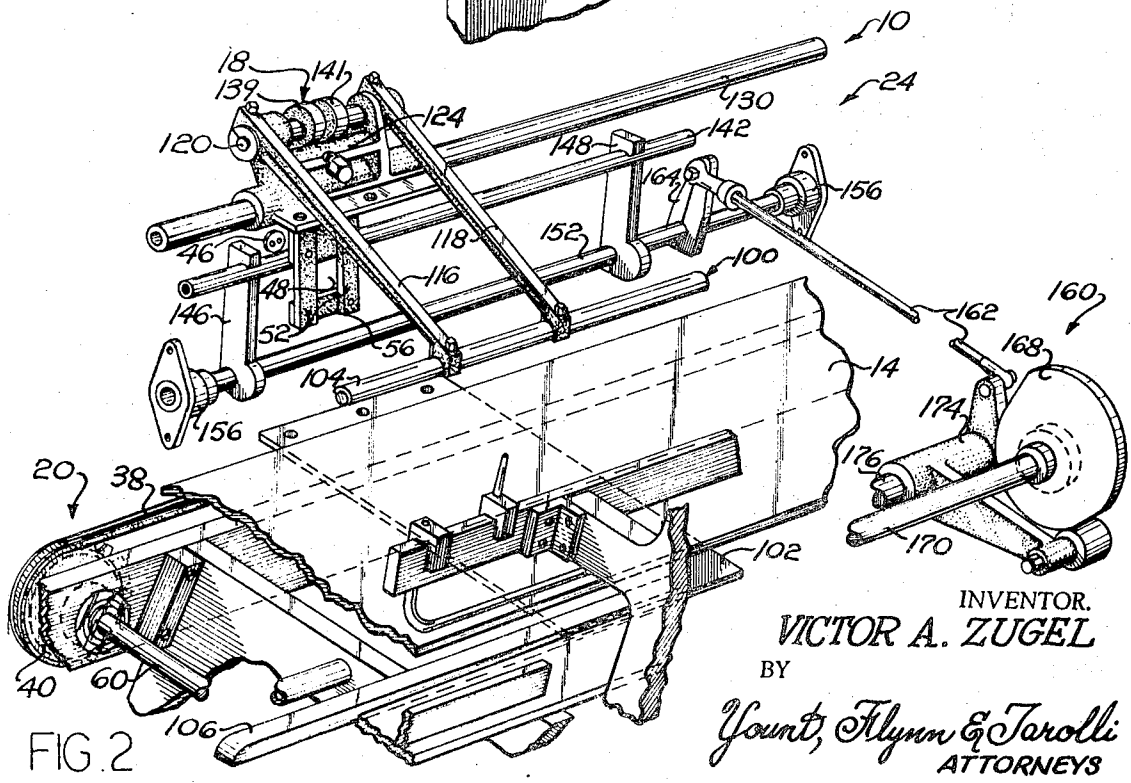


FIG. 2

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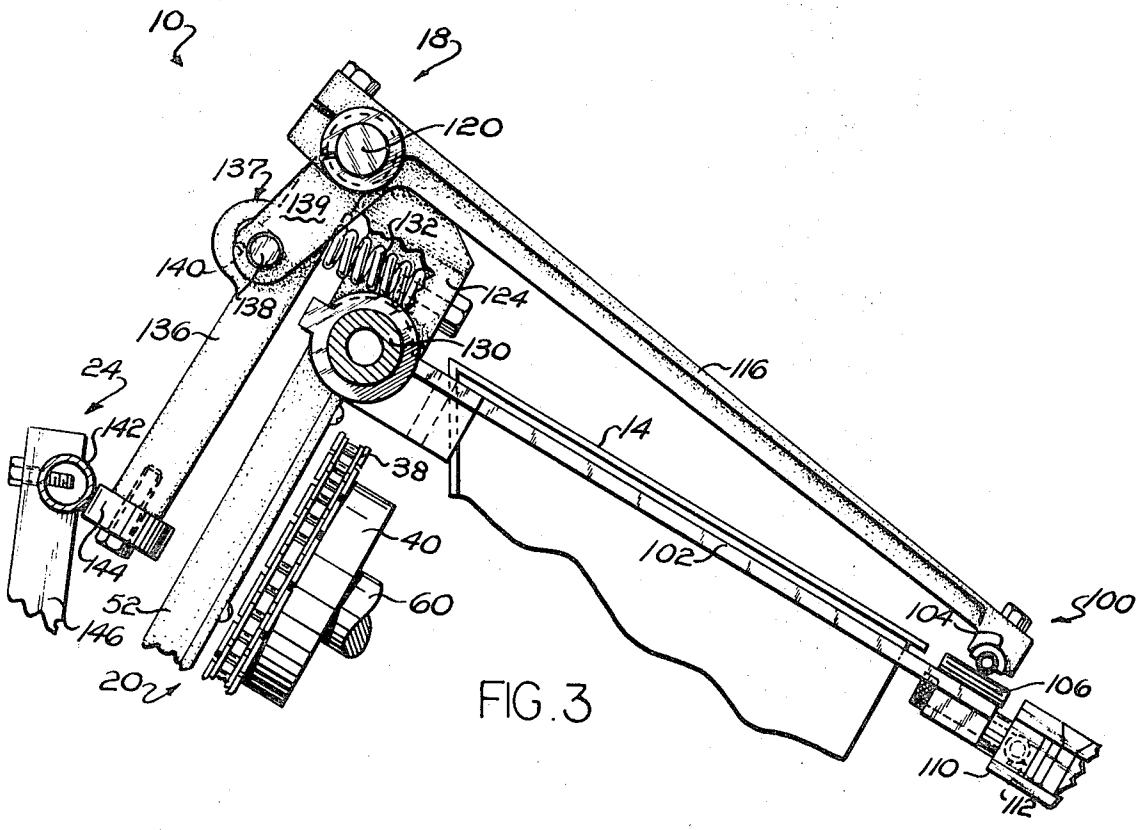


FIG. 3

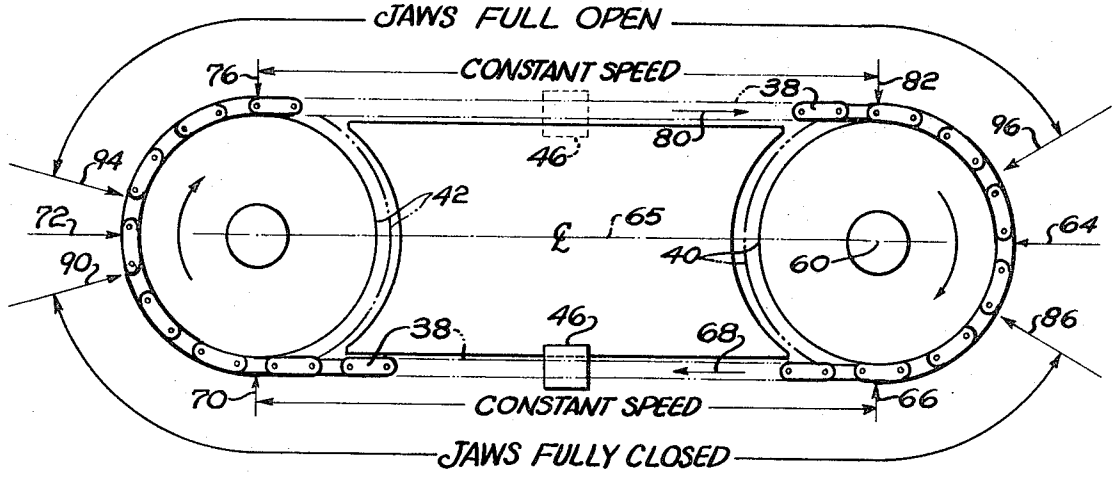


FIG. 4

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SHUTTLE ASSEMBLY

In a known machine for handling signatures or gathers of sheet material, a shuttle grips the signatures or gathers and transfers them to a location under a stitcher or stapler head. The shuttle includes a crank assembly for moving a clamp or gripper assembly with a simple harmonic motion. After the clamp assembly has grippingly engaged the signatures or gathers, the clamp assembly and signatures or gathers are accelerated to a peak or maximum velocity by the crank assembly and then immediately decelerated to move the signatures into position beneath the stapler head. This known shuttle assembly is generally satisfactory in its operation. However, during high speed operation, difficulty has been encountered in controlling the movement of the signatures or gathers due to the relatively high peak velocity to which the clamp assembly and signatures or gathers are accelerated.

The relatively high peak velocity is necessitated by both the speed of operation of the machine and the simple harmonic type of movement which the crank assembly imparts to the clamp assembly and signatures or gathers. With the continuous acceleration and subsequent deceleration which characterizes simple harmonic motion, the clamp assembly must obtain a relatively high peak velocity in order to move the signatures or gathers through the desired distance. The rapid acceleration of the clamp assembly to the relatively high peak velocity and the rapid deceleration from the relatively high peak velocity subjects the signatures or gathers to forces which makes controlling their movement and position difficult. Therefore, it is an object of this invention to provide a new and improved high speed shuttle which is dependable in operation for moving signatures or gathers from one location to another with a relatively low peak velocity.

Another object of this invention is to provide a new and improved shuttle of a relatively simple structure including a clamp assembly for gripping sheet material, a chain drive means for reciprocating the clamp assembly and an actuator for operating the clamp assembly to grip the sheet material at one location and release the sheet material at another location with the chain drive means constructed in such a manner as to maintain a relatively low peak or operating velocity during a major portion of a forward stroke of the clamp assembly.

Another object of this invention is to provide a shuttle assembly having a sheet material engaging clamp assembly, a chain drive mechanism for reciprocating the clamp assembly by accelerating the clamp assembly to an operating speed during initial portions of forward and reverse strokes of the clamp assembly, maintaining the clamp assembly at the operating speed during major portions of the strokes and decelerating the clamp assembly during end portions of the strokes.

These and other objects and features of the invention become more apparent upon a consideration of the following description taken in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view of a book stitcher having a shuttle assembly embodying the present invention;

FIG. 2 is a fragmentary, partially exploded perspective view of the book stitcher of FIG. 1;

FIG. 3 is an elevational sectional view further illustrating the structure of the shuttle assembly; and

FIG. 4 is a schematic illustration of the operation of a drive mechanism of the shuttle assembly.

The invention relates to a shuttle assembly for transporting signatures or gathers of sheet material from one location to another. In order to minimize the peak velocity at which the signatures or gathers are moved, the shuttle assembly includes a drive mechanism which is operable to move the signatures or gathers at a substantially constant operating velocity for a major portion of a forward stroke of the shuttle assembly.

Although the present invention can advantageously be used in many different machines, such as collators and saddle gatherers, a shuttle assembly 10 illustrating the invention is shown in FIG. 1 in a book stitcher 12 which is intended for use in connection with a sidebinder (not shown). The book stitcher 12 includes a sloping tray or base 14 for supporting

signatures which are received from a conveyor of the associated sidebinder. The shuttle assembly 10 has a clamp assembly 18 which grips or clamps the signatures received from the sidebinder at a location to the right of the position shown in FIG. 1. The clamp assembly 18 is then moved toward the left, as shown in FIG. 1, on a forward stroke of the shuttle assembly 10 by a drive mechanism 20.

An actuator assembly 24 operates the clamp assembly 18 to release the signatures when they are positioned beneath the heads 28 and 30 of a stapler or stitcher 32 at an end portion of the forward stroke of the clamp assembly. The drive mechanism 20 then moves the clamp assembly 18, on a reverse stroke, back to the right (as viewed in FIG. 1) to engage a second group signatures while the stitcher 32 stitches or staples the first group of signatures. The first group of signatures is then moved from its position beneath the stitcher heads 28 and 30, by another shuttle assembly (not shown) or any other suitable conveyor, while the shuttle assembly 10 is operated for another forward stroke to move the second group of signatures into position beneath the stitcher heads 28 and 30.

During high speed operation of the book stitcher 12, the shuttle assembly 10 moves the signatures from the sidebinder receiving location to the work location beneath the stitcher heads 28 and 30 at a relatively low peak or maximum operating velocity which is maintained throughout a major portion of the forward stroke of the shuttle assembly. To this end, the clamp assembly 18 is accelerated to the operating velocity during a relatively short initial or beginning portion of the forward stroke. Similarly, the clamp assembly 18 is decelerated during a relatively short end portion of the forward stroke. Since the clamp assembly 18 is maintained at the operating velocity for the major portion of the stroke, the clamp assembly can be moved quickly through a relatively large distance along the tray 14 at a relatively low maximum velocity. If the clamp assembly was merely accelerated and decelerated with a simple harmonic motion the maximum velocity which would be required to move the signatures from the receiving location to the work location beneath the stitcher heads 28 and 30 would be comparatively high for a given rate of operation of the book stitcher.

To provide the rapid acceleration to an operating velocity which is maintained for a major portion of the stroke and the subsequent rapid deceleration, the drive mechanism 20 includes an endless chain 38 which engages a drive sprocket 40 and an idler sprocket 42. One of the links of the chain 38 is connected to the clamp assembly 18 by a pivotal connector assembly 46 which slidably engages a slot 48 in an outwardly projecting shuttle drive plate 52. The shuttle drive plate 52 has a tie or end plate 56 forming an end portion of the slot 48 to limit the movement of the connector assembly 46 relative to the drive plate 52. Upon rotation of the drive sprocket 40, under the influence of a drive shaft 60 (see FIGS. 2 and 3), the chain 38 is moved along a continuous or circuitous path to reciprocate the clamp assembly 18 relative to the tray 14.

When the clamp assembly 18 is at the beginning of a forward stroke, the clamp assembly and connector assembly 46 are at the far right as viewed in FIG. 1 and indicated schematically at 64 in FIG. 4. The centers of the drive and idler sprockets 40 and 42 are located on a longitudinal axis 65 extending parallel to the path of movement of the signatures and the longitudinal axis of the tray 14. Therefore, continued rotation of the drive sprocket 40, in a clockwise direction as viewed in FIG. 4, moves the connector assembly 46 downwardly and toward the left of the point 64, as viewed in FIG. 4, to accelerate the clamp assembly 18. When the connector assembly 46 reaches a point 66 where it begins to move along a path parallel to the longitudinal axis 65 of the drive mechanism, the clamp assembly 18 has been accelerated to a peak or maximum operating velocity in the forward direction, indicated by the arrow 68.

The operating velocity is maintained substantially constant through a major portion of the forward stroke of the clamp as-

sembly 18 to enable the clamp assembly to cover a relatively large distance at a relatively low peak or maximum velocity. Accordingly, the connector assembly 46 is moved along a path parallel to the longitudinal axis 65 of the drive mechanism or between the point 66 where the acceleration of the clamp assembly 18 stops and a point 70 where deceleration of the clamp assembly begins. The clamp assembly is decelerated by continuing the rotation of the drive sprocket 40 and idler sprocket 42, to move the drive chain and connector assembly 46 around the idler sprocket 42, until the end of the forward stroke of the clamp assembly is reached when the connector assembly 46 is at the point 72.

Upon beginning the reverse stroke, the clamp assembly is accelerated to the peak or maximum operating velocity as the connector assembly 46 moves from the point 72 to a point 76, located ninety degrees from the point 72. The clamp assembly 18 then moves at the previously mentioned operating speed for a major portion of its reverse stroke, that is in the direction of the arrow 80 in FIG. 4. At a point 82 the link to which the connector assembly 46 is attached engages the drive sprocket 40 and the clamp assembly 18 begins to decelerate from the operating speed by movement of the connector assembly and link around the drive sprocket 40. When the connector assembly 46 reaches the point 64, the reverse stroke ends and the clamp assembly 18 is in position to begin the next forward stroke. Thus, it can be seen that the drive mechanism 20 rotates an endless chain 38 about a circuitous path to quickly accelerate the clamp assembly 18 to an operating speed, maintain the operating speed constant for a major portion of a stroke and decelerate the clamp assembly at the end of the stroke. Although an idler sprocket 42 has been illustrated in connection with the drive sprocket 40, it is contemplated that other means could be provided for guiding the movement of the chain 38.

When the clamp assembly 18 grips signatures being transported to the book stitcher 12 by the conveyor of the associated sidebinder, the clamp assembly 18 should be traveling at least as fast as the speed of movement of the signatures under the influence of the sidebinder conveyor to provide a smooth transfer of the signatures from the sidebinder conveyor to the shuttle assembly 10 without damage to the signatures. Accordingly, the clamp assembly 18 firmly grips the signatures after the clamp assembly has been accelerated during the initial part of its forward stroke to a velocity in a direction parallel to the longitudinal axis 65 and corresponding to the velocity of the signatures. Thus, the clamp assembly 18 firmly grips the signatures when the connector assembly 46 is at a point indicated at 86 in FIG. 4. The acceleration of both the clamp assembly and signatures is then continued until the clamp assembly reaches the operating speed or velocity.

In the present embodiment of the invention, the clamp assembly 18 releases the signatures shortly before reaching the end of the forward stroke, that is when the connector assembly 46 is at a point indicated at 90 in FIG. 4. This enables the clamp assembly 18 to be fully open and disengaged from the signatures shortly after the return stroke of the clamp assembly begins with the connector assembly 46 at the point indicated at 94 in FIG. 4. The clamp assembly 18 remains in the open or released condition until it approaches the end of the reverse stroke, and the beginning of the next forward stroke is imminent. The connector assembly 46 is then at a point indicated at 96 in FIG. 4. The clamp assembly 18 completes its closing or gripping action on the next group of signatures when the connector assembly 46 reaches the point 86. It should be noted that the clamp assembly 18 makes two complete strokes, that is a forward and reverse stroke, for each group of signatures which is transferred from the sidebinder conveyor to the book stitcher. Therefore, the operating velocity of the clamp assembly during the major portion of the strokes, that is the velocity of the clamp assembly as the connector assembly 46 moves between the points 66 and 70 and 76 and 82, is approximately twice the velocity at which the signatures are moved by the sidebinder conveyor.

To enable the clamp assembly 18 to securely grip the signatures as the clamp assembly is moved along the tray 14 by the action of the drive mechanism 20, the clamp assembly 18 includes a shuttle gripper or clamp 100 (see FIG. 3). The gripper or clamp 100 includes a lower shuttle plate 102 and an elongated upper shuttle bar or jaw 104 which cooperates with a lower shuttle bar or jaw 106 on the shuttle plate 102 to clampingly engage the signatures. The relatively long upper shuttle bar or jaw 104 and lower shuttle bar or jaw 106 extend generally parallel to the longitudinal axis 65 of the drive mechanism 20 and have a length which is advantageously somewhat greater than the length of the signatures to enable the jaws or bars 104 and 106 to securely grip the signatures through out their length. A guide track 110 (FIG. 3) engages a slide 112 which is connected to the shuttle plate 102 and bar 106 to support the bar and plate for movement along the tray 14 and to position the shuttle plate 102 relative to the tray.

A pair of shuttle arms 116 and 118 (see FIG. 2) are connected to the shuttle bar 104 for moving the upper shuttle bar 104 toward and away from the lower shuttle bar 106 to thereby operate the clamp 100 between an open or release condition and a closed or gripping condition. To this end, the arms 116 and 118 are fixedly secured to a shaft 120 which is rotatably mounted on a body portion 124 of the clamp assembly 18 and extends parallel to the longitudinal axis 65 of the drive mechanism 20. The shuttle drive plate 52 is also connected to the body portion 124 of the clamp assembly. Therefore, driving forces are transmitted from the drive mechanism 20 through the connector assembly 46 and drive plate 52 to the body portion 124 of the clamp assembly. These drive forces cause the clamp assembly 18 to slide along a fixed shuttle guide shaft 130, which is parallel to the longitudinal axis 65 of the drive mechanism 20, to move the clamp 100 relative to the tray 14.

The upper shuttle bar or jaw 104 is urged toward the lower shuttle bar or jaw 106 by a spring 132 (see FIG. 3). The spring 132 engages an outwardly and downwardly projecting operating arm 136 which is connected to the shaft 120. Thus, the spring 132 presses against the body 124 to urge the operating arm 136 and arms 116 and 118 in a clockwise direction (as viewed in FIG. 3). This action of the spring 132 biases the jaws or bars 104 and 106 to a closed condition in which the jaws are operative to firmly clamp signatures being transported by the shuttle assembly 10.

To facilitate the handling of both large and small groups of signatures, the shuttle assembly 10 includes an adjustment means 137 (FIG. 3) which enables the space between bars 104 and 106 to be varied when the bars are in the closed position. The adjustment means 137 includes a threaded lock shaft 138 which projects from the flange or arm 139 which is fixedly connected to the shaft 120. The lock shaft extends through an arcuate slot 140 in the operating arm 136 and a hole in a flange or arm 141 (see FIG. 1) which is also fixedly connected to the shaft 120. By loosening a suitable locknut (not shown) on the threaded lock shaft 138, the operating arm 136 can be moved relative to the arms 139 and 141 to adjust the space between the bars 104 and 106 to clampingly receive groups of signatures of a desired thickness.

The actuator assembly 124 includes an elongated gripper operating or actuator bar 142 (see FIGS. 1 and 2) which is selectively operable to actuate the clamp 100 from the closed condition to the open condition. To this end, the actuator bar 142 extends parallel to and is at least as long as the path of movement of the signatures and is continuously engaged by a roller 144 as the clamp assembly 18 is reciprocated along the tray 14. The actuator bar 142 is fixedly connected by arms 146 and 148 to a support bar 152 which is rotatably mounted by bearings 154 and 156 (FIG. 2). Rotation or oscillation of the support bar 152 pivots the actuator bar 142 about the support bar to force the shuttle operating arm 136 inwardly against the influence of the spring 132. This movement of the operating arm 136 pivots the shuttle arms 116 and 118 and the upper gripper bar or jaw 104 in a counterclockwise direction

(as viewed in FIG. 3) to the open condition to thereby release the signatures being transported by the shuttle assembly 10.

A control assembly 160 (see FIG. 2) is provided for operating the actuator assembly 124 when the clamp assembly 18 is in the previously mentioned positions relative to the tray 14. Thus, the control assembly 160 and actuator assembly 124 cooperate with the clamp assembly 18 to operate the clamp assembly between the open and closed conditions at predetermined times during the forward and reverse strokes of clamp assembly. Accordingly, the control assembly 160 is connected by a rod 162 to a drive arm 164 which is in turn fixedly connected to the support bar 152. The control assembly 160 is operable to oscillate or pivot the support shaft 152 by movement of the rod 162 and the drive arm 164. As was previously explained, oscillation of the support shaft 152 moves the actuator bar 142 to pivot the operating arm 136 and thereby open and close the clamp 100. To provide the oscillation of the support shaft 152, the control assembly 160 includes a cam 168 which is mounted on a drive shaft 170 and is engaged by a follower arm 174 which is connected to the rod 162 and is pivotally mounted on a support shaft 176.

The operation of the actuator assembly 24 is coordinated with the position of the clamp assembly 18 relative to the tray 14 by operatively connecting the drive shaft 170 for the cam 168 and the drive shaft 60 for the drive sprocket 40 to a common source of power or drive shaft. This interconnection results in the drive chain 38 being driven in a predetermined relationship with the cam 168. Thus, by adjusting the position of the cam 168 and the drive chain 38, the clamp assembly 18 can be positioned relative to the cam 168 so that the actuator assembly 24 begins or initiates the operation of the clamp assembly 18 from the closed or clamping condition to the open or released condition when the connector assembly 46 is in any desired position. In the present embodiment of the invention, the clamp assembly begins to close when the connector assembly 46 is approaching the end of a reverse stroke, as is indicated schematically at 96 in FIG. 4. The upper and lower clamp bars or jaws 104 and 106 begin to open when the connector assembly 46 is ending a reverse stroke, as is indicated at 90 in FIG. 4.

The cam 168 is advantageously formed to maintain the actuator assembly 24 in an operated condition, so that the clamp bars 104 and 106 are maintained in the open condition, for both the major portion and part of the deceleration portion of the reverse stroke. To this end, the actuator bar 142 presses against the roller 144 to hold the operating arm 136 inwardly when the connector assembly 42 is being moved from the position indicated at 94 in FIG. 4 to the position indicated at 96 in FIG. 4. During this portion of the reverse stroke, the roller 144 rolls along the actuator bar 142 to hold the operating arm 136 inwardly against the spring 132. When the connector assembly 46 reaches the position indicated at 96 in FIG. 4, the follower arm 174 is moved by the cam 168 to pivot the actuator bar 142 outwardly. When the connector assembly 46 has reached the position indicated schematically at 86 in FIG. 4, the clamp assembly 18 is in the closed condition due to the action of the spring 132. The jaws 104 and 106 are then in firm clamping engagement with the next set of signatures.

In view of the foregoing description, it can be seen that the shuttle assembly 10 includes a drive mechanism 20 which moves the clamp assembly 18 with a forward stroke from a position wherein the clamp assembly engages signatures received from an associated sidebinder or other machine to a working location whereat the signatures are stitched. During the major portion of the movement between the two locations the drive mechanism 20 moves the clamp assembly 18 at a constant, relatively low operating speed or velocity. To provide this constant relatively low operating speed or velocity, the drive mechanism 20 includes a drive chain 38 which is driven by a sprocket 40 to quickly accelerate the clamp assembly to the operating speed once the signatures are clampingly engaged by the jaws 104 and 106 of the clamping assembly. Toward the end of the forward stroke, the clamp assembly is decelerated and the jaws 104 and 106 are opened, by operation of the actuator assembly 24, to release the signatures. Since the operating velocity is maintained for the majority of the forward stroke, the peak or maximum velocity to which the clamp assembly 18 must be accelerated is relatively low for a given speed of operation of the book stitcher 12. The actuator assembly 24 and control assembly 160 are provided for operating the clamp assembly 18 between the open and closed conditions at predetermined portions of the forward and reverse strokes.

Although a particular embodiment of the shuttle assembly 10 has been illustrated in connection with a book stitcher, it is contemplated that the shuttle assembly 10 will be used on many different machines wherein sheet material is transported from one location to another. Of course, the specific structure of the shuttle assembly 10 may be modified somewhat to suit the environment of the particular machine in which the shuttle assembly is to be used. It should also be understood that although a specific embodiment of the drive mechanism 20 has been illustrated, it is contemplated that various changes will be made in the specific structure shown while maintaining the capability of accelerating the clamp assembly to an operating speed and maintaining the clamp assembly at the operating speed for a major portion of the stroke of the clamp assembly. Therefore, while a particular embodiment of the invention has been shown, it should be understood, of course, that the invention is not limited thereto since many modifications may be made; and it is contemplated to cover by the appended claims any such modifications as fall within the true spirit and scope of the invention.

I claim:

1. A shuttle assembly for transporting sheet material relative to a base, said shuttle assembly comprising a clamp assembly supported from said base for gripping said sheet material, chain drive means drivingly connected to said clamp assembly for reciprocating said clamp assembly back and forth relative to said base along a substantially straight path, said chain drive means being operative during forward and reverse strokes of said clamp assembly to accelerate said clamp assembly to an operating speed, to maintain said operating speed during major portions of said strokes, and to decelerate said clamp assembly toward the ends of said strokes, actuator means operatively associated with said clamp assembly for actuating said clamp assembly between an open condition in which said clamp assembly is ineffective for gripping said sheet material and a closed condition in which said clamp assembly grips said sheet material, and control means for selectively operating said actuator means to maintain said clamp assembly in said open condition during said major portion of said reverse stroke and to maintain said clamp assembly in said closed condition during said major portion of said forward stroke whereby said shuttle assembly is operable to transport said sheet material in a forward direction relative to said base at said operating speed during said major portion of said forward stroke.

2. A shuttle assembly as set forth in claim 1 wherein said chain drive means includes a drive sprocket and an endless chain mounted in engagement with said drive sprocket and adapted to be driven thereby, said endless chain having at least one link connected to said clamp assembly to thereby move said clamp assembly upon rotation of said drive sprocket, said drive sprocket and chain being operatively connected in a predetermined relationship with said control means to coordinate the operation of said clamp assembly between said open and closed condition by said actuator means with the movement of said clamp assembly to predetermined locations along said base.

3. A shuttle assembly as set forth in claim 2 wherein said clamp assembly includes an elongated gripper member extending generally parallel to a longitudinal axis of said chain and having a longitudinal extent which is at least substantially as great as the longitudinal extent of said sheet material for clampingly engaging said sheet material throughout substantially its entire length.

4. A shuttle assembly as set forth in claim 1 wherein said actuator means includes an elongated member extending generally parallel to the path along which said clamp assembly is reciprocated by said drive means and having a length which is at least as great as the length of said path, said control means including cam means operatively associated with said member and said chain drive means for moving said member relative to said base when said clamp assembly is in one of a plurality of predetermined relationships with said base, and said clamp assembly includes an outwardly projecting operating arm which is maintained in engagement with said member during said reciprocation of said clamp assembly, said operating arm being pivotal about an axis extending generally parallel to said member by movement of said member under the influence of said cam means to thereby operate said clamp assembly between said open and closed conditions.

5. A shuttle assembly as set forth in claim 4 wherein said clamp assembly includes an elongated gripper means having opposing material engaging jaws extending generally parallel to said member, one of said opposing jaws being movable relative to the other in response to pivoting of said operating arm to thereby operate said clamp assembly between said open and closed conditions.

6. A shuttle assembly for transporting sheet material along a base from one location to another, said shuttle assembly including a clamp assembly supported by said base and movable along said base between said locations, a chain drive mechanism for reciprocating said clamp assembly back and forth relative to said base along a substantially straight path, said chain drive mechanism including an endless chain having at least one link connected to said clamp assembly and a drive sprocket mounted in driving engagement with said chain for moving said chain along a circuitous path to accelerate said clamp assembly to an operating speed and to decelerate said clamp assembly, and an actuator assembly operatively associated with said clamp assembly and said chain drive mechanism for operating said clamp assembly from an open condition to a closed condition to clampingly engage said sheet material at said one location when said clamp assembly is moving under the influence of said chain drive mechanism at a speed which is less than said operating speed and for operating said clamp assembly from said closed condition to said open condition to release said sheet material at said other location when said clamp assembly is moving under the influence of said chain drive mechanism at a speed which is less than said operating speed, said actuator assembly including an elongated member extending generally parallel to the path along which said clamp assembly is reciprocated by said chain drive mechanism and having a length which is at least as great as the length of said path and means for moving said member relative to said base when said clamp assembly is at either one of said locations, said clamp assembly including an operating arm which is maintained in engagement with said member during said reciprocation of said clamp assembly, said operating arm being pivotal about an axis extending generally parallel to said member upon movement of said member when said clamp assembly is at either one of said locations to thereby operate said clamp assembly between said open and closed conditions.