A window covering drive system mountable in a sash frame, such as an interior sash, for use in operating a window covering mounted to the sash. The drive system including a drive component coupleable to the covering, the drive component including a belt and a belt tensioning mechanism providing pre-tension in the belt and sustaining tension during operation of the drive system. The drive system also including an operator assembly slidably mounted to the sash and coupled to the drive component, such that linear motion of the operator assembly results in movement of the belt and rotary action of the drive component to operate the covering. The drive system may include a frame connecting corner lock configured with features that couple to the drive component. Additionally, a covering operating mechanism may be included having a lift spool with a varying diameter about which a lift cord is wound and unwound.
Fig. 22
WINDOW COVERING DRIVE SYSTEM

[0001] This application claims the benefit of U.S. provisional patent application Ser. No. 60/642,813, filed Jan. 11, 2005, and entitled WINDOW COVERING DRIVE SYSTEM, hereby incorporated by reference in its entirety.

[0002] The complete disclosures of commonly assigned U.S. provisional patent applications entitled MOVABLE LIGHT LATCH, Ser. No. 60/642,811 (attorney docket no. 301235), WINDOW COVERING LEVELING MECHANISM AND METHOD, Ser. No. 60/642,812 (attorney docket no. 308472) and WINDOW ASSEMBLY WITH MOVABLE INTERIOR SASH, Ser. No. 60/643,064 (attorney docket no. 295468), all filed on Jan. 11, 2005, are herein incorporated by reference in their entirety.

TECHNICAL FIELD

[0003] The present invention is related to window and door components, including window coverings and drive systems for raising, lowering and tilting such coverings.

BACKGROUND OF THE INVENTION

[0004] Window coverings, such as, but not limited to, shades and blinds, have historically been mounted to walls, doors or frames surrounding the window or other viewing area being covered. Some mounting hardware is designed to be attached on either side of the window, such that the window covering is sized to extend across the viewing area of the window and the window frame. Other mounting hardware is designed to be attached within the frame structure, such that the window covering is sized to extend only across the viewing area of the window.

[0005] In recent years, mounting methods and hardware have been introduced that provide for the mounting of window coverings directly to the glazing panel or glass portion of the window. In addition, window coverings may also be provided to be mounted between two glazing panels on a multiple panel window unit, that is, internal within the window structure. For these units, the innermost glazing or viewing panel may be removable to provide access to the window covering.

[0006] In most window coverings, a drive system is provided to operate the window covering causing a covering portion to extend across the viewing area to provide coverage and/or be retracted from the viewing area to allow for viewing through the viewing area. Some window coverings also, or alternatively, have a tilting feature by which the covering portion tilts to cover or provide viewing through the viewing area. The drive system is often actuated by a pull cord and/or a rotating wand, which are accessible to the user. Other drive systems, including electric and remote controlled systems, have also been introduced. However, there remains a need for improved drive systems for window coverings.

BRIEF SUMMARY OF THE INVENTION

[0007] The present invention provides, in first embodiment, a window covering drive system mountable in a sash frame for use in operating a window covering mounted to the sash frame. The drive system includes a drive component couplable to the window covering, the drive component including a drive belt and a belt tensioning mechanism for providing pre-tension in the belt and sustaining tension during operation of the drive system. Also included is an operator assembly slidably mounted to the sash frame and coupled to the drive component, such that linear motion of the operator assembly results in movement of the drive belt and rotary action of a portion of the drive component to operate the window covering. The drive component may include a drive belt having two ends and a spring clamp connecting the two belt ends and applying tension to the drive belt. The drive component may also include a limiter for limiting a gap between the two belt ends and movement of the limiter increases tension in the drive belt, such that the drive belt is pulled about a drive pulley.

[0008] A second embodiment provides a window covering drive system mountable in a sash frame for use in operating a window covering mounted to the sash frame, the sash frame formed from a plurality of frame members connected together at corners of the sash frame. The drive system includes a drive component couplable to the window covering and a corner lock configured to attach to and connect two adjoining frame members at the corner of the sash frame, with the corner lock including a recess formed to receive and couple to a portion of the drive component. In addition, an operator assembly slidably mounted to the sash frame and coupled to the drive component is included, such that linear motion of the operator assembly results in rotary action of a portion of the drive component to operate the window covering. The drive component may include a drive belt and a pair of pulleys with a portion of the belt and a pulley received within the recess of the corner lock. The drive component may also include a second corner lock with a portion of the drive belt and the second pulley received within a recess of the second corner lock.

[0009] A third embodiment provides a window covering drive system mountable in a sash frame for use in operating a window covering mounted to the sash frame. The drive system includes a window covering operating mechanism configured to operate the window covering through actuation of a lift cord. The operating mechanism includes a drive shaft and a lift spool assembly coupled to the drive shaft, the lift spool assembly including a rotatable lift spool having first and second ends and a varying diameter with the diameter decreasing from the first and second ends toward a middle, with the lift spool attached to a first end of the lift cord and configured to receive the lift cord in a series of coils when the lift spool rotates in a first direction. The drive system also includes a drive component coupled to the drive shaft of the window covering operating mechanism and an operator assembly slidably mounted to the sash frame and coupled to the drive component, such that linear motion of the operator assembly results in rotary action of a portion of the drive component to rotate the drive shaft and operate the window covering operating mechanism.

[0010] While multiple embodiments are disclosed, still other embodiments of the present invention will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the invention. As will be realized, the invention is capable of modifications in various obvious aspects, all without departing from the spirit and scope of the present invention. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.
BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0011] While the invention is amenable to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and are described in detail below. The intention, however, is not to limit the invention to the particular embodiments described. On the contrary, the invention is intended to cover all modifications, equivalents, and alternatives falling within the scope of the invention as defined by the appended claims.

[0012] FIG. 1 is a front elevation view of a window unit having a primary sash in accordance with the present invention.

[0013] FIG. 2 is a perspective view of the primary sash in FIG. 1 having a secondary sash that has been swung open.

[0014] FIG. 3 is a partial perspective view of a sash or window frame and a window covering mountable to the frame in accordance with the present invention.

[0015] FIG. 4 is a detailed perspective view of the sash or window frame of FIG. 3.

[0016] FIG. 5 is a partial detailed view of a corner of the frame and a corner of the window covering, shown in FIG. 3.

[0017] FIG. 6 is a top view of one embodiment of a window covering in accordance with the present invention.

[0018] FIG. 7 is a front view of the window covering of FIG. 6.

[0019] FIG. 8 is an end view of the window covering of FIG. 6.

[0020] FIG. 9 is a partial detailed view of a lift and tilt cord spool usable in the window covering of FIG. 6.

[0021] FIG. 10 is a top view of a second embodiment of a window covering in accordance with the present invention.

[0022] FIG. 11 is a front view of the window covering of FIG. 10.

[0023] FIG. 12 is an end view of the window covering of FIG. 10.

[0024] FIG. 13 is a partial detailed view of lift cord spool usable in the window covering of FIG. 10.

[0025] FIG. 14 is a partial detailed view of a corner of the frame and a corner of a third embodiment of a window covering in accordance with the present invention.

[0026] FIG. 15 is a top view of the window covering of FIG. 14.

[0027] FIG. 16 is a front view of the window covering of FIG. 14.

[0028] FIG. 17 is a partial view of window covering head rail of the window covering of FIG. 14.

[0029] FIG. 18 is an end view of the window covering of FIG. 14.

[0030] FIG. 19 is a partial detailed view of one embodiment of a bottom rail including a leveling mechanism in accordance with the present invention.

[0031] FIG. 20 is an exploded view of the bottom rail and leveling mechanism of FIG. 19.

[0032] FIG. 21 is a cross-sectional view of a portion of the leveling mechanism of FIG. 19.

[0033] FIG. 22 is a perspective view of a sash or window frame with a window covering mounted thereto and a drive system for the window covering in accordance with the present invention.

[0034] FIG. 23 is a partial detailed view of a timing pulley assembly that is a portion of the drive system of FIG. 22.

[0035] FIG. 24 is a perspective view of a timing pulley unit, as shown in FIG. 23.

[0036] FIG. 25 is an exploded view of the timing pulley unit of FIG. 24.

[0037] FIG. 26 is a partial detailed view of an idler pulley assembly, as that is another portion of the drive system of FIG. 22.

[0038] FIG. 27 is a perspective view of an idler pulley unit, as shown in FIG. 26.

[0039] FIG. 28 is an exploded view of the idler pulley unit of FIG. 27.

[0040] FIG. 29 is a partial detailed view of an operator assembly that is a further portion of the drive system of FIG. 22.

[0041] FIG. 30 is a partial detailed view of a handle assembly and a slider to which it is mounted in accordance with the present invention.

[0042] FIG. 31 is a partial cross-sectional front view of the slider and timing belt clamp assembly in accordance with the present invention.

[0043] FIG. 32 is a partial cross-sectional end view of the handle assembly in accordance with the present invention.

[0044] FIG. 33 is a front elevation view of an interior side of the sash or window frame of FIG. 3, shown without a window covering.

[0045] FIG. 34 is a top perspective view of a first embodiment of a corner lock having two dissimilar legs in accordance with the present invention.

[0046] FIG. 35 is a bottom perspective view of the corner lock in FIG. 34.

[0047] FIG. 36 is an underside view of the corner lock of FIG. 34, which has been rotated.

[0048] FIG. 37 is a top view of the corner lock of FIG. 34.

[0049] FIG. 38 is a top perspective view of a second embodiment of a corner lock having two similar legs in accordance with the present invention.

[0050] FIG. 39 is a top view of the primary and secondary sashes shown in FIG. 2, including a restraining device, with the secondary sash swung open.

[0051] FIG. 40 is a top view of the sashes in FIG. 39, with the secondary sash in a closed position.

[0052] FIG. 41 is a perspective view of the sashes of FIG. 39, similar to FIG. 2, but including the restraining device.
FIG. 42 is a top schematic view of the window unit of FIGS. 1 and 41 showing both the primary and interior sashes opened.

DETAILED DESCRIPTION OF THE INVENTION

In FIGS. 1 and 2, a window unit 100, also referred to as a fenestration product, is shown including a first glazing panel 105 that is also known as a viewing panel or glass pane. The first glazing panel 105 is supported in the window unit 100 by a window frame 110 and a primary sash 120. In this embodiment, the window unit 100 is shown as a casement-type window in which the primary sash 120 is hinged on a first side 121 and is latched on an opposite side 122 by latch 123. When the latch 123 is released, the primary sash 120 may be swung open, usually to the outside or away from an operator of the window unit 100, by rotation or other operation of a handle 124. It is to be noted, however, that the primary sash 120 may be provided in a double-hung window, an awning-type window, a fixed window, a sliding door, a hinged door, or any other suitable fenestration product.

In some windows, only one glazing panel is provided. In other, more energy efficient windows, two or more glazing panels may be provided. In these windows, one of the glazing panels may be operable and/or removable. In some embodiments, a secondary glazing panel may be mounted within the primary sash 120 in conjunction with the first glazing panel 105. In other embodiments, a secondary sash may be provided with a secondary glazing panel surrounded by a minimal frame, which is then removably coupled to the primary sash 120. In the present embodiment, a secondary or interior sash 130 including a secondary glazing panel 135 mounted within a secondary sash frame 131 is provided within the sash 120. As shown in this embodiment, the secondary sash 130 includes a more substantial frame 131 that is hinged at one side 132 to the sash 120. The secondary sash 130 may then be swung open about the hinged side 132 for access to the first glazing panel 105 or an interior portion of the secondary glazing panel 135. See FIG. 42 for an example.

Referring now to FIG. 3, a window covering 1000 is shown configured to mount into a window frame 1100. As stated above, the frame 1100 may be part of a window or door, such that the covering 1000 is configured to cover some or all of the glazing panel (such as 105) of that window or door. However, as used herein the term window covering refers to any such covering. In one embodiment, the window frame 1100 is a primary sash frame, such as frame 120. Alternatively, the window frame 1100 is a secondary sash frame, such as frame 131 of interior sash 130, which may or may not be operable and/or removable. The frame 1100 includes a plurality of members including first and second stiles 1101, 1102, respectively, a head member 1103 and a sill member 1104 (not shown). In a preferred embodiment, the first and second stiles 1101, 1102, head member 1103 and sill member 1104 are formed as extrusions, such as aluminum extrusions. Further, in the illustrated embodiment, each member of frame 1100 is formed from the same extrusion profile. However, other materials, such as wood or fiberglass, profiles and formation methods may also be used to provide frame components having the necessary features.

The window covering 1000 may be mounted to the frame 1100 using a variety of methods and/or a variety of coupling devices. In one embodiment, the window covering 1000 includes a generally longitudinal post receiver 1003 located at a first end 1001 and a generally transverse post receiver 1004 located at a second end 1002 of a top rail 1010. These two receivers 1003, 1004 connect to first and second posts 1106, 1107, respectively, mounted to the head member 1103 of window frame 1100, as shown in FIG. 4. In the illustrated embodiment, the window covering 1000 also includes a drive shaft coupling 1005 located at the first end 1001, which is received in a shaft coupling 1108 positioned through the first stile 1101 of window frame 1100. Operation of the drive shaft coupling 1005 results in operation of the window covering 1000, as described below.

To releasably attach the window covering 1000 to the head member 1103 in this embodiment, receiver 1003 on the top rail 1010 is slidingly engaged with the mounting post 1106. The depth of the receiver 1003 is sufficient so that the drive shaft coupling 1005 engages with the shaft coupling 1108 on the first stile 1101. The top rail 1010 is then rotated toward the frame 1100 until the mounting post 1107 slides toward the receiver 1004. A handle, such as loop 1009, may be provided to aid in removal of the window covering 1000 from the frame 1100.

It is to be noted, however, that the window covering 1000 may alternatively be reversed within the frame 1100. In such a configuration, the shaft coupling 1108 would be provided in the second stile 1102 and the two receivers 1003, 1004 would be reversed on the window covering 1000. In addition, the drive shaft coupling 1005 would be provided at the second end 1002 of the window covering 1000. In all other respects, the window covering 1000 would function in the same manner.

The window covering 1000 further includes end covers 1006 located at the first and second ends 1001, 1002. In addition, a plurality of intermediate covers 1007 are provided across the width of the window covering 1000. These end covers 1006 and intermediate covers 1007 are usually provided as packaging to protect the window covering during transport and installation. The window covering 1000 also includes a top rail 1010 configured to be located adjacent to, or near, the head member 1103 of the frame 1100. The top rail 1010 is shown covered by a top rail cover 1011. Opposite from the top rail 1010, the window covering 1000 includes bottom rail 1012. The window covering 1000 is provided in a width 1015 that is generally the same or smaller than an inner distance 1105 between the first and second stiles 1101, 1102 of the frame 1100. The window covering 1000 has an interior side 1016 which is configured to face into a room or building and an exterior side 1017 configured to generally face out of a room or building. In general, a user would interact with the frame 1100 on the interior side 1016. The exterior side 1017 of the window covering 1000 and frame 1100 are shown in FIG. 3.

In FIG. 5, a detailed view of the first end 1001 of the window covering 1000 shows the drive shaft coupling 1005 and the lateral post receiver 1003. In this embodiment, the window covering 1000 is a blind 1020 with a plurality of horizontal slats 1021 that are capable of tilting using a ladder cord 1022, and being raised and lowered using a lift cord 1023. The bottom rail 1012 is shown having an end cap 1013 at each end. The end cover 1006 is not shown.
As shown in FIGS. 6-9, the blind 1020 is shown without the top rail cover 1011. The top rail 1010 includes a support channel 1024 to which a plurality of components for lifting and tilting the slats 1021 of the blind 1020 are mounted. At the first end 1001, a shaft coupler housing 1025 couples the drive shaft coupler 1005 to a shaft 1014. The shaft 1014 extends generally along the width 1015 of the window covering 1000 from the first end 1001 to the second end 1002. In one embodiment, the drive shaft coupler 1005 is a hexagonal protrusion extending from the shaft coupler housing 1025 and having a cross-sectional dimension across the flaps of about 0.2 inches. The shaft 1014, on the other hand, is a generally square rod having a cross-sectional dimension of about 0.13 inches.

The shaft 1014 connects the shaft coupler housing 1025 to a brake 1026 mounted to the support channel 1024, which provides resistance for the rotation of the shaft 1014 during lowering of the blind 1020. At the second end 1002 of the blind 1020, an end cap housing 1027, mounted in the support channel 1024, supports the first end of the shaft 1014. The end cap housing 1027 includes the generally transverse post receiver 1004 described above. In one embodiment, the transverse post receiver 1004 includes a detent or notch 1008 that aids in capturing the post 1107 and holding it securely. Mounted in the support channel 1024 along the shaft 1014, between the brake 1026 and the end cap housing 1027, are a plurality of spool assemblies 1030. The number and location of these spool assemblies 1030 depends on the width 1015 of the window covering 1000. Each spool assembly 1030 is the same, so only one will be described.

The spool assembly 1030 includes a spool 1031 rotatably mounted on a spool base 1033 and retained on the base 1033 by a spool cap 1034 and a spool retainer 1032. As shown in FIG. 8, the shaft 1014 passes through the spool 1031 in a passageway 1036 having a cross-sectional shape that is complementary to the shape of the shaft 1014. Therefore, as the shaft 1014 rotates, the spool 1031 also directly rotates.

The lift cord 1023 connects to the spool 1031 at the spool cap 1034 and passes through an opening 1037 in the spool base 1033 and the support channel 1024, as shown in FIG. 9. The lift cord 1023 then passes down through the blind slats 1021, as shown in FIG. 5, to the bottom rail 1012 and is secured at cord fastener 1029, as shown in FIG. 7. As the spool 1031 rotates in response to rotation of the shaft 1014, the lift cord 1023 either winds around the spool 1031 or unwinds from the spool 1031, depending on the direction of shaft rotation. The winding and unwinding of the lift cord 1023 causes the raising and lowering, respectively, of the bottom rail 1012 resulting in contraction and extension, respectively, of the blind 1020, as is known in the venetian blind and mini-blind industry.

The spool 1031 also includes a ladder cord portion 1035 extending from an end of the spool 1031. In one embodiment, the ladder cord portion 1035 has a smaller diameter than the spool 1031 and is positioned generally over the lift cord opening 1037. A ladder cord of a horizontal, venetian or mini blind, as is known in the art and is generally shown in FIG. 8, includes two spaced apart vertical cords connected by a plurality of generally horizontal cross cords in a generally ladder shape. The cross cords are positioned under each blind slat 1021 with the vertical cords positioned on the interior 1016 and exterior 1017 sides of the blind 1020. The ladder cord 1022 is wound about the ladder cord portion 1035 at a top end and is positioned about the slats 1021 down the length of the blind 1020. The ladder cord 1022 is secured to the bottom rail 1012 at a fastener 1028, as shown in FIG. 7.

As the spool 1031 and ladder cord portion 1035 rotate, the ladder cord 1023 tilts one direction or the other, resulting in a tilting of the individual slats 1021 of the blind 1020. When the slats 1021 reach a limit of tilt in either direction, the ladder cord 1022 begins to slip about the ladder cord portion 1035 as the spool 1031 continues to rotate. When the direction of rotation is reversed, the ladder cord 1021 tilts in the opposite direction until its limit is reached in that direction. Therefore, in this embodiment, rotation of the shaft 1014 results in both lifting and tilting of the blind slats 1021.

In a second embodiment, the window covering 1000 is a pleated, honeycomb or cellular shade 1040, as shown in FIGS. 10-13. For clarity, components that are the same or similar to the first embodiment will be labeled with the same numbers.

The shade 1040 includes a top rail 1010 including a support channel 1024 and a shaft 1014. The drive shaft coupler 1005 extends from and is coupled to a first end 1001 of the shaft 1014 at the shaft coupler housing 1025. The shaft 1014 is supported at the other end by the end cap housing 1027. Mounted on the support channel 1024 and positioned along the length of the shaft 1014 are the brake 1026 and a plurality of spool assemblies 1030.

In this embodiment, instead of a plurality of blind slats 1021 positioned between the top rail 1010 and the bottom rail 1012, the shade 1040 includes material 1041. The material 1041 may be accordion pleated or may be formed as compressible hexagonal cells 1042, as shown in FIG. 12. The lift cord 1023 is attached at the spool assembly 1030 and is threaded through the lift cord opening 1037. It is then routed down through the material 1041 and is secured at the bottom rail 1012. As the spool 1031 rotates and the lift cord 1023 winds about the spool 1031, the bottom rail 1012 rises and compresses the material 1041, sandwiching it between the top rail 1010 and bottom rail 1012, as is known in the industry. As the lift cord 1023 unwinds from the spool 1031, the bottom rail 1012 lowers and the material 1041 unfolds or extends.

In this embodiment, the material only extends and retracts, it does not tilt. Thus, there is no need for ladder cords or a tilting mechanism. However, in order to make the spool assembly 1030 more universal and interchangeable, the same spool assembly 1030 may be used for both types of window coverings 1000, a blind 1020 or a shade 1040.

Referring to FIGS. 11 and 13, another embodiment of a cord spool 1330 is shown. A spool 1331 is rotatably mounted within a spool housing 1332, similar to the prior described embodiment. The lift cord 1023 is connected to the spool 1331 at a first end 1333 and wraps around the spool 1331 toward a second end 1334, where it is routed through an opening 1335 toward the window covering material 1041. In this embodiment, the housing 1332 includes a tapered ramp 1336 configured to angle a coil of the lift cord 1023 as it wraps around the spool 1331. This
ramp 1336 pushes the coil of the lift cord 1023 over, toward the first end 1333 of the spool 1331, in order to make room for the next coil. This leaves the spool 1331 and the coil of the lift cord 1023 free to wind without having to push the prior coil of the lift cord 1023 over.

[0073] In order to aid in cord wind up and organization about the spool 1331, the spool 1331 includes a first taper 1337 from the second end 1334 toward the center portion 1338 of the spool 1331. This first taper 1337 is configured as a varying diameter that decreases from the second end 1334 toward the center portion 1338 of the spool 1331. This first taper 1337 facilitates movement of the coils of the lift cord 1023 as they are pushed over by the ramp 1336. As the spool 1331 fills with coils of lift cord 1023, and the coils near the first spool end 1333, they can build up slack. In order to keep the cord 1023 organized, the spool 1331 has a second taper 1339 that increases from the center portion 1338 of the spool 1331 toward the first end 1333. That is, the diameter of the spool 1331 varies as it increases from the center portion 1338 toward the first end 1333. The center portion 1338 may be generally straight between the first and second tapers 1337, 1339. Alternatively, the spool 1331 may have a curved surfaces or may be formed as a continuous concave profile.

[0074] In a third embodiment, the window covering 1000 is a fixed blind 1050, as shown in FIGS. 14-18, including a plurality of blind slats 1051 supported by a plurality of ladder cords 1052. In this embodiment, the blind 1050 remains at a fixed length. That is, it does not raise or lower. However, the blind slats 1052 do tilt by manipulation of the ladder cords 1052, as described below.

[0075] The fixed blind 1050 includes a top rail 1053 including an upper plate 1054 held spaced apart from a lower rail 1055 by a plurality of hooks 1056. The upper plate 1054 includes the lateral post receiver 1003 as at the first end 1001 and the generally transverse post receiver 1004 of the second end 1002, shown best in FIG. 15. The lower rail 1055 includes a center hub 1058 that generally extends the length of the lower rail 1055. The lower rail 1055 is mounted such that it is configured to rotate a pre-determined distance about the center hub 1058 at the hooks 1056.

[0076] Each hook 1056 includes a hub end 1057 that is effectively wrapped around the hub 1058, as shown best in FIG. 18. In one embodiment, the hub end 1057 is formed to serve as a rotational stop for the lower rail 1055 in one direction. For example, the hub end 1057 of the hook 1056 may be bent at 90 degrees to a plane of the hook 1056, such that it is generally parallel to the lower rail 1055. The hook 1056 itself serves as a rotational stop in the opposite direction.

[0077] In this embodiment, the ladder cords 1052 are connected directly to the lower rail 1055 or at the hooks 1056. When the lower rail 1055 rotates about the hub 1058 at the hooks 1056, the ladder cords 1052 move to tilt the slats 1051 of the fixed blind 1050, as is known in the art. At the first end 1001 of the top rail 1053, the drive shaft coupler 1005, as described in the prior embodiments, is mounted to the hub 1058, as shown in FIG. 16. Rotation of the drive shaft coupler 1005 thus causes rotation of the lower rail 1055 and tilting of the slats 1051.

[0078] In both the first and second embodiments described above, the window covering 1000 includes a bottom rail 1012 to which the lift cords and/or ladder cords are connected to facilitate manipulation of the window coverings 1000. Referring to FIGS. 19-21, an alternative embodiment of the bottom rail 1012 is shown including an adjustable leveling mechanism 1060 for use in adjusting the level of the bottom rail 1012 easily and simply. In this embodiment, the lift cord 1023 connects to the leveling mechanism 1060 by passing through a T-plug 1061 at opening 1062. The T-plug 1061 is positioned within the bottom rail 1012. The lift cord 1023 then is directed toward and connected to a cord adjuster 1063, such as a zip tie, zip strip or other suitable component preferably having a plurality of directional teeth 1064.

[0079] The cord adjuster 1063 engages a locking mechanism 1065, which is received within the bottom rail 1012. The locking mechanism 1065 is held in position within the bottom rail 1012 by a split plug 1066 that engages a hole or other suitable opening in the bottom rail 1012. The locking mechanism 1065 also includes one or more strip retention members 1067 provided within one or more strip openings 1068.

[0080] In operation, the lift cord 1023 is threaded through the opening 1062 on the T-plug 1061 and is attached to the cord adjuster 1063. The cord adjuster 1063 is then inserted into and through one of the strip openings 1068, such that the strip retention members 1067 engage with the teeth 1064. When leveling of the bottom rail 1012 is desired, the cord adjuster 1063 is pulled through the strip opening 1068 until the lift cord 1023 is at a desired length. The directional nature of the teeth 1064 discourages movement of the cord adjuster 1061 in the opposite direction, such that the lift cord 1023 is held in the desired position. Once a level bottom rail 1012 is achieved, a portion 1069 of the cord adjuster 1063 protruding out of the strip openings 1068 on a side opposite the T-plug 1061 may be trimmed off so that it doesn’t extend beyond the end of the bottom rail 1012. The end cap 1013 is then placed on the end of the bottom rail 1012, thereby covering up the leveling mechanism 1060 from view.

[0081] As shown and described above, all of the embodiments of the window covering 1000 are designed to be interchangeable and replaceable within the frame 1100. The drive shaft coupler 1005 is provided in each embodiment as part of the top rail 1010, 1053 and is operationally coupled to the covering portion, such as the shade material or slats, so as to move, that is, raise and lower and/or tilt the shade material or slats upon rotation of the drive shaft coupler 1005. The top rail 1010, 1053 in each embodiment also includes the lateral post receiver 1003 and the generally transverse post receiver 1004 for removably mounting the window covering 1000 into the frame 1100. Although shown as being mounted in a removable frame 1100, any of the window covering 1000 embodiments described herein may also be used with sliding doors, hinged doors, fixed windows, double hung windows, casement windows, awning windows, or any other type of window or door configurations.

[0082] The frame 1100 is shown again in FIG. 22 with the window covering 1000 attached adjacent the head member 1103. Also shown is a window covering drive system 1110 operatively coupled to the drive shaft coupler 1005 so as to operate the window covering 1000 as needed by lifting, lowering and/or tilting. In one embodiment, the drive system
mounts within the first stile 1101 and includes a drive belt 1112, a timing pulley assembly 1120, an idler pulley assembly 1140 and an operator assembly 1160 that provides an interface, at handle assembly 1180, between a user and the window covering drive system 1110.

[0083] As shown in FIGS. 23-25, the timing pulley assembly 1120 includes a timing pulley unit 1121 about which a top end 1113 of the timing belt 1112 loops. The timing pulley unit 1121 includes a mounting plate 1122 having a bearing post 1123 protruding therefrom, a pair of mounting holes 1130 and a plurality of alignment protuberances 1129. A bearing 1124 is received on the bearing post 1123 and a timing or drive pulley 1125 is positioned over the bearing 1124. The timing pulley 1125 includes a plurality of timing teeth 1126 formed about its circumference. A generally hollow shaft coupler 1127 extends from the timing pulley 1125 and includes flat-walled inner perimeter 1128 configured to correspond to and couple with the drive shaft coupler 1005. In this embodiment, the shaft coupler 1127 is equivalent to shaft coupler 1008 shown in FIG. 4.

[0084] The timing pulley unit 1121 is suitably positioned with respect to the stile 1101 of the frame 1100 by using the plurality of protuberances 1129 and is secured thereto using fasteners 1131 through mounting holes 1130. A washer 1132 may be provided for smoother operation and better durability of the timing pulley assembly 1120. The drive belt 1112 rides over the teeth 1126 of the timing pulley 1125, such that longitudinal movement of the belt 1112 causes the timing pulley 1125 to rotate and thus rotate the drive shaft coupler 1005.

[0085] At the opposite end of the frame 1100, as shown in FIGS. 26-28, near the sill member 1104, the idler pulley assembly 1140 is positioned. The idler pulley assembly 1140 includes an idler pulley unit 1141 about which a bottom end 1114 of the timing belt 1112 loops. The idler pulley unit 1141 includes a mounting plate 1142 having a bearing post 1143 protruding therefrom, a pair of mounting holes 1150 and a plurality of alignment protuberances 1149. A bearing 1144 is received on the bearing post 1143 and an idler pulley 1145 is positioned over the bearing 1144. The idler pulley 1145 includes a positioning knob 1146 extending from the idler pulley 1145, which includes a bearing surface 1147 around its perimeter.

[0086] The idler pulley unit 1141 is suitably positioned with respect to the stile 1101 of the frame 1100 by using the plurality of protuberances 1149 and is secured thereto using fasteners 1151 through mounting holes 1150. A washer 1152 may be provided for smoother operation and better durability of the idler pulley assembly 1140. The drive belt 1112 rides around the idler pulley 1145 in conjunction with the timing pulley 1125 for smooth and continuous longitudinal motion of the belt 1112 with the belt 1112 maintained at a suitable tension. In one embodiment, the timing belt 1112 is a continuous loop belt that may be inelastic or elastic to some extent and may tensioned externally or integrally.

[0087] The operator assembly 1160 is shown in detail in FIGS. 29-32. In this embodiment, the drive belt 1112 is split with a gap 1111, instead of being continuous. A belt clamp assembly 1161 couples to the belt 1112 at the gap 1111, so as to complete the belt loop. The belt clamp assembly 1161 includes a pair of belt clamps 1162, each having an open slot 1163 into which a drive belt end is slid. In a preferred embodiment, each slot 1163 includes an inner profile 1164 that mates with a profile of the belt 1112, thereby facilitating the sliding engagement and gripping of the belt 1112 by the clamps 1162. In one embodiment, the drive belt 1112 includes belt teeth 1115 and the belt clamps 1162 include mating inner teeth 1168 in slot 1163, as shown in FIG. 31.

[0088] The pair of belt clamps 1162 is joined together by a resilient element 1166, such as a spring as shown. Other types of resilient elements may also be used. Tension within the drive belt 1112, for example between the drive pulley 1125 and idler pulley 1145, may be adjusted using the resilient element 1166, as opposed to relying on the resiliency of the belt material. In one embodiment, the drive belt 1112 is inelastic; however, other types of drive belts, including elastic belts, may also be used. The resilient element 1166 may be chosen and/or configured to provide the necessary resiliency needed for a particular window or drive system. When assembled, the resilient element 1166 may be stretched to a specific length and then connected to the belt 1112 at the clamps 1162, thus pre-tensioning the belt 1112. This feature eliminates the need to tension the belt 1112 after assembly and compensates for expansion and/or contraction within the frame 1100.

[0090] The sled 1170 also includes a pair of channel connectors 1172, which may be integrally formed with the sled 1170 or may be attached in a suitable manner. Each channel connector 1172 is configured to removably engage a guide channel 1119 formed in stile 1101. In one embodiment, the guide channel 1119 is formed generally parallel to accessory channel 1118, but at about 90 degrees to accessory channel 1118. The sled 1170 is thus free to slide along accessory channel 1118 while being retained in the guide channel 1119. The sled 1170 also includes a pair of bosses 1173 and a mounting hole 1174. In one embodiment, the sled 1170 is rotated into guide channel 1119 and inserted, then fastened after a handle is slid over the top of the extrusion.

[0091] A handle bracket 1181 including a plurality of mounting holes 1183, 1184 is positioned over the sled 1170 such that the outer pair of holes 1183 is aligned and engage the pair of bosses 1173 on the sled 1170. The other mounting hole 1184 aligns with the mounting hole 1174 on the slider such that a fastener, such as screw 1188, may be used to secure the bracket 1181 to the sled 1170. Other methods of securing the bracket 1181 and the sled 1170 together may also be used.

[0092] The handle bracket 1181 includes a pair of end stops 1182 formed at each end of the bracket 1181. When the bracket 1181 is connected to the sled 1170, the end stops 1182 at least partially cover the keyed opening 1157 at each
end of the sled 1170. Once the belt clamp assembly 1161 is slid into the keyed opening 1171 and the bracket 1181 is connected to the sled 1170, the belt clamp assembly 1161 is captured within the sled 1170.

[0093] The belt clamp assembly 1161 has a nominal length 1167 of about 1.7 inches (43 millimeters). Stretching of the resilient element 1165 may result in an increase in this length. The keyed opening 1171 of the sled 1170 has a length 1176 of about 2.0 inches (51 millimeters) long. Therefore, when the belt clamp assembly 1161 is captured within the sled 1170, the belt clamp assembly 1161 has a length of travel or play of about 0.3 inches (8 millimeters). This length of travel or play within the sled 1170 acts as a limiter on the gap 1111 between the ends of the drive belt 1112, such that the ends of the drive belt 1112 cannot be stretch apart farther than this amount when the belt clamp assembly 1161 is positioned within the sled 1170.

[0094] The handle assembly 1180 further includes a handle mounting member 1185 formed at an angle from the bracket 1181. In a preferred embodiment, the handle mounting member 1185 may be formed integrally with the bracket 1181, as shown. However, a separate handle mounting member 1185 attached to the bracket 1181 may also be provided. The handle mounting member 1185 is configured to extend from the bracket 1181 on the sled 1170 over a wall of the stile 1101. A handle 1186 is then mounted to the handle mounting member 1185 adjacent an exterior surface of the stile 1101. The handle 1186 is then accessible by an operator. An alternative handle 1187 is shown in FIG. 30.

[0095] Movement of the handle 1186 by sliding along the stile 1101 results in sliding movement of the sled 1170 and thus linear movement of the drive belt 1112 captured within the sled 1170. As the drive belt 1112 moves linearly, the tension pully 1145 rotates, thus rotating the drive shaft coupler 1005 and operating the window covering 1000. The play within the sled 1170 for the belt clamp assembly 1161, as described above, provides delayed engagement of the drive belt 1112 when the handle 1186 is operated by a user. That is, the drive belt 1112 does not begin to move until the linear movement of handle 1186 and thus the sled 1170 causes the sled 1170 to engage the belt clamp assembly 1161. The purpose of this play is to pull the drive belt 1112 around the drive pulley 1145 instead of push it, order to maintain tension in the drive belt 1112 rather than pull on and stretch the spring 1166 during operation. Thus, there is never slack in the drive belt 1112 and no tension adjustment is needed, either during assembly or in the field during or after installation. In addition, the spring allows for thermal expansion and tolerance take-up. For embodiments having a window covering 1000 that lifts, lowers and tilts, the first portion of the handle and belt movement results in tilting of the window covering 1000, with continued movement causing lifting or lowering of the window covering 1000. For lift only embodiments, movement of the handle and belt results in lifting or lowering of the covering 1000. For tilt only embodiments, movement of the handle and belt results in tilting in either direction.

[0096] In FIG. 33, the interior side 1016 or user side of the frame 1100 is shown, including the operator handle 1186 by which a user operates the window covering 1000 (not shown in this view). The frame 1100 includes the first and second stiles 1101, 1102, head member 1103 and sill member 1104. Since this view is from the opposite direction, first member 1101 is shown on the right side of the frame 1100, instead of the left side as shown in FIG. 3. A pair of slider mechanisms 125 are also shown engaged with the first stile 1101. These slider mechanisms 125 unlatch the secondary sash frame 1100 from the primary sash frame 120, as shown in FIGS. 2 and 42, allowing the secondary sash frame 1100 to pivot away from the primary sash frame 120, as described above.

[0097] In one embodiment, the frame members are connected at each corner 1109 by a corner lock 1200. In one embodiment, each corner lock 1200 for all four corners 1109 is the same configuration, however, different corner locks may also be provided, as needed. As shown in FIGS. 34-38, in a first embodiment, the corner lock 1200 is a generally ‘L’ shaped component having first and second legs 1201, 1202, respectively, with an outer side 1205 and an underside 1206. The legs 1201, 1202 are connected at a joint 1203. Each leg 1201, 1202 is configured to be inserted into accessory channel 1118 of each frame member 1101, 1102, 1103 or 1104 with the underside 1206 placed adjacent to the accessory channel 1118. The joint 1203 includes an opening 1204 which connects with an inner channel 1207. After the legs 1201, 1202 are inserted into the frame members 1101, 1102, 1103, 1104, adhesive or another joining compound may be injected into the frame corner 1109 at the joint opening 1204 to secure the members together at the corner 1109.

[0098] The corner lock 1200 of the present invention includes numerous features that are preferable formed integral to the legs 1201, 1202. These features serve a function beyond just connecting the frame members together and integrate with other aspects of the window frame 1100, such as the window covering 1000 and its drive system 1110. In a preferred embodiment, the corner lock 1200 is molded from a suitable material, including but not limited to plastic, glass-filled nylon, aluminum or other moldable material. Alternatively, the corner lock 1200 may be machined or otherwise formed using a suitable formation method from a suitable material to provide the desired features.

[0099] The first leg 1201 includes a plurality of mounting holes that may be threaded 1212 or non-threaded 1211. In one embodiment, the threaded hole 1212 in each corner lock 1200 of the head member 1103 is used to mount one of the first and second posts 1106 or 1107 used for attaching the window covering 1000 to secondary sash frame 1100. Alternatively, threaded hole 1212 may be a non-threaded hole, and self-tapping fasteners may be used for attachment.

[0100] On the outer side 1205, the first leg 1201 also includes an ‘L’ shaped opening 1213, a keyhole opening 1214 and a post 1215. On the underside 1206, the ‘L’ shaped opening 1213 extends into a generally triangular shaped opening 1216. As a result, an overhanging lip 1217 is provided between the outer side 1205 and the underside 1206. The keyhole opening 1214 extends into an oval opening 1218 on the underside 1206. The purpose of these components will be described in more detail below.

[0101] The second leg 1202 includes a recessed area 1221 having a generally curved end 1222. An opening 1223 passes through the recessed area 1221. A larger diameter, slightly recessed bore 1224 surrounds the opening 1223 at the curved end 1222 of the recessed area 1221. An elongated post 1225 protrudes from the recessed area 1221 and
includes at least one hole 1226. The underside 1206 of the second leg 1202 includes the opening 1223 and the hole 1226. A mounting bore 1227 is also provided in the non-recessed area of the second leg 1202.

[0102] In one embodiment, the components of the second leg 1202 are used for the connection of the timing and idler pulley assemblies 1120, 1140 in the first stile 1101. Referring again to FIG. 23, the washer 1132 is placed within the recessed bore 1224 and the timing pulley assembly 1121 is positioned with the timing pulley 1125 in the curved end 1222 of the recessed area 1221. The shaft coupler 1127 passes through the opening 1223 to receive the drive shaft coupler 1005. The timing pulley assembly 1121 attaches to the second leg 1202 with fasteners 1131 passing through mounting holes 1130 into the mounting bore 1227 and one of the holes 1226. The recessed area 1221 provides space for the pulley assembly 1221 and the drive belt 1112. Referring to FIG. 26, the idler pulley assembly 1140 also mounts to the frame 1100 using the second leg 1202 of the corner lock 1200, in a manner similar to the timing pulley assembly 1120. For the idler pulley assembly 1140, the positioning knob 1146 passes through the opening 1223, instead of the shaft coupler 1126.

[0103] For the second stile 1102, the second leg 1202 of each corner lock 1200 may provide only the connection function. In this way, the corner lock 1200 has multiple uses with the same configuration, thereby reducing inventory, assembly time and production costs. Alternatively, a second embodiment of a corner lock 1230 is shown in FIG. 38. In this embodiment, the corner lock 1230 includes first and second legs 1231, 1232 that are configured the same. Each leg 1231, 1232 has the same features as first leg 1201. This corner lock 1230 may be used to connect the sill member 1104 and the second stile 1102. Since there is no operator drive assembly 1110 to be connected to this stile 1102, the pulley assembly connection features of the second leg 1202 are not required.

[0104] In FIGS. 39-41, one use of the components of the first leg 1201 of the corner lock 1200 is shown. A restraining device 1240 includes a spring slider 1241 configured to slideably mount within the accessory channel 1118 of head member 1103. The spring slider 1241 is symmetrically configured to include a pair of posts 1242 and a raised center member 1243 having a pair of overhanging ears 1244. On one end, a resilient member 1245, such as a spring, connects the spring slider 1241 to a first corner lock 1208 at post 1215.

[0105] At the other end, the spring slider 1241 is connected to a second corner lock 1209 at the center member 1243 by a cord 1246. The cord 1246 is anchored at a first end 1247 in keyhole opening 1214. It then wraps around the center member 1243 of the spring slider 1241 and is restrained from sliding off the center member 1243 by one of the ears 1244. The cord 1246 then extends back to the corner lock 1200 and threads into the one end of the ‘L’ shaped opening 1213 passing under the overhanging lip 1217 and out the other end. The cord 1246 extends toward and is removably secured at a second end 1249 to an anchor 1248 mounted to the primary sash 120 or other window frame.

[0106] When the secondary or interior sash is closed with respect to the primary sash, as shown in FIG. 40, the resilient member 1245 is in a generally relaxed configuration with the spring slider 1241 slid toward the first corner lock 1208. In this configuration, the head member 1103 of the secondary sash frame 1100 passes under the anchor 1248 mounted to an underside of the head piece of the window frame, as shown in FIGS. 40 and 41. When the secondary sash is opened with respect to the primary sash or window frame, as shown in FIG. 39, the cord 1246 extends from the anchor 1248. As the cord 1246 extends away from the frame 1100, the spring slider 1241 is pulled toward the second corner lock 1209 and the resilient member 1245 is stretched between the spring slider 1241 and the first corner lock 1208.

[0107] The restraining device 1240 provides a restraining mechanism to keep the secondary sash from opening too far. The resilient member 1245 both causes the cord 1246 to be recaptured within the head member 1103 upon closing of the frame 1100 and encourages the closing of the frame 1100 with little or no effort on the part of the user opening the secondary sash. Once opened, the second end 1249 of the cord 1246 may be disengaged from the anchor 1248 so that the secondary sash may be opened further and/or removed from the primary sash or window frame.

[0108] Various modifications and additions can be made to the exemplary embodiments discussed without departing from the scope of the present invention. Accordingly, the scope of the present invention is intended to embrace all such alternatives, modifications, and variations as fall within the scope of the claims, together with all equivalents thereof.

What is claimed is:

1. A window covering drive system mountable in a sash frame of a window for use in operating a window covering mounted to the sash frame, the drive system comprising:

   a drive component couplable to the window covering, the drive component including a drive belt and a belt tensioning mechanism that provides pre-tension in the belt and sustains tension during operation of the drive system; and

   an operator assembly slidably mounted to the sash frame and coupled to the drive component, such that linear motion of the operator assembly results in movement of the drive belt and rotational action of a portion of the drive component to operate the window covering.

2. The window covering drive system of claim 1, wherein the drive component is positioned within a member of the sash frame.

3. The window covering drive system of claim 1, wherein the drive component further comprises a pair of pulleys around which the drive belt is positioned, with at least one of the pair of pulleys coupled to a drive coupling configured to releasably couple to the window covering, such that movement of the drive belt results in rotation of the pair of pulleys and the drive coupling so as to operate the window covering.

4. The window covering drive system of claim 1, wherein the drive belt comprises two ends and wherein the belt tensioning mechanism comprises a spring clamp connecting the two belt ends and applying tension between the two belt ends.

5. The window covering drive system of claim 4, wherein the drive component further comprises a limiter that limits
a gap between the two belt ends and movement of the limiter increases tension in the drive belt, such that the drive belt is pulled about a drive pulley.

6. The window covering drive system of claim 1, wherein the operator assembly comprises a sled that slides within a channel in the sash frame and an operator handle coupled to the sled and positioned on the sash frame for use by an operator, the sled coupled to the drive component, such that sliding movement of the operator handle by an operator results in sliding movement of the sled and actuation of the drive component to operate the window covering.

7. The window covering drive system of claim 6, wherein the drive belt comprises two ends and wherein the belt tensioning mechanism comprises a spring clamp connecting the two belt ends and applying tension between the two belt ends and wherein the sled is configured to slidably receive the spring clamp and to serve as a limiter that limits a gap between the two belt ends, such that the drive belt is pulled about a pair of pulleys to reduce slack and maintain tension in the drive belt.

8. The window covering drive system of claim 1, wherein the sash frame comprises a plurality of members configured to connect at corners of the frame and further comprising a corner lock configured to attach to and connect two adjoining frame members at the corner of the frame, the corner lock including a recess formed to receive and couple to a portion of the drive component.

9. The window covering drive system of claim 8, wherein the sash frame further comprises at least two corner locks and wherein the drive component further comprises a pair of pulleys about which the drive belt is positioned and wherein each of the pulleys are received by the corner locks such that each corner lock recess receives a portion of the drive belt and a pulley.

10. The window covering drive system of claim 1, further comprising a window covering operating mechanism configured to operate the window covering through actuation of a lift cord, the operating mechanism including:

a drive shaft coupled to the drive component; and

a lift spool assembly coupled to the drive shaft, the lift spool assembly including a rotatable lift spool having first and second ends and a varying diameter with the diameter decreasing from the first and second ends toward a middle, the lift spool attached to a first end of the lift cord and configured to receive the lift cord in a series of coils when the lift spool rotates in one direction.

11. The window covering drive system of claim 10, wherein the lift spool assembly further comprises a housing supporting the lift spool, the housing including an angled surface positioned to engage the lift cord as it first winds about the lift spool at the second end of the lift spool and to urge the lift cord coil away from the second end toward the middle of the spool so as to make room for a subsequent coil of the lift cord as the lift spool continues to rotate.

12. The window covering drive system of claim 1 in combination with a window or window sash including the sash frame and a glazing panel mounted therein.

13. The window covering drive system of claim 12, wherein the sash frame is openable with respect to the window or window sash and wherein the sash frame comprises an opening restrictor mounted to the openable sash frame on one end and to the window or window sash on the other end, the opening restrictor restricting the openability of the openable frame.

14. The window or sash of claim 13, wherein the openable sash frame rotates to swing open and shut with respect to the window or window sash, and wherein the opening restrictor comprises:

a first cord anchor mounted to the openable sash frame;

a second cord anchor mounted to the window or window sash;

a spring anchor mounted to the openable sash frame at an opposite end than the first cord anchor;

a slider slidably mounted to the openable sash frame between the first cord anchor and the spring anchor and resiliently coupled to the spring anchor by a resilient member; and

a cord connected to the first cord anchor at a first cord end, routed around the slider and connected to the second cord anchor at a second cord end,

such that opening movement of the openable sash frame results in extension of the cord away from the window or window sash with a corresponding movement of the slider toward the first cord anchor and away from the spring anchor causing an extension of the resilient member.

15. A window covering drive system mountable in a sash frame for use in operating a window covering mounted to the sash frame, the sash frame formed from a plurality of frame members connected together at corners of the frame, the drive system comprising:

a drive component coupleable to the window covering;

corner lock configured to attach to and connect two adjoining frame members at the corner of the sash frame, the corner lock including a recess formed to receive and couple to a portion of the drive component; and

an operator assembly slidably mounted to the sash frame and coupled to the drive component, such that linear motion of the operator assembly results in rotary action of a portion of the drive component to operate the window covering.

16. The window covering drive system of claim 15, wherein the drive component comprises a drive belt and first and second pulleys about which the drive belt is positioned, with the first pulley mounted within the recess of the corner lock and a portion of the drive belt passing within the recess and about the first pulley.

17. The window covering drive system of claim 16, further comprising another corner lock configured to attach to and connect two adjoining frame members at the corner of the sash frame, the corner lock including a recess formed to receive and couple to the second pulley with a portion of the drive belt passing within the recess and about the second pulley.

18. The window covering drive system of claim 15, further comprising a window covering operating mechanism configured to operate the window covering through actuation of a lift cord, the operating mechanism including:
a drive shaft coupled to the drive component at the corner lock; and

a lift spool assembly coupled to the drive shaft, the lift spool assembly including a rotatable lift spool having first and second ends and a varying diameter with the diameter decreasing from the first and second ends toward a middle, the lift spool attached to a first end of the lift cord and configured to receive the lift cord in a series of coils when the lift spool rotates in a first direction.

19. The window covering drive system of claim 18, wherein the lift spool assembly further comprises a housing supporting the lift spool, the housing including an angled surface positioned to engage the lift cord as it first winds about the lift spool at the second end of the lift spool and to urge the lift cord coil away from the second end toward the middle of the spool so as to make room for a subsequent coil of the lift cord as the lift spool continues to rotate.

20. The window covering drive system of claim 18, wherein the drive component further comprises a shaft coupling housed within the corner lock and coupled to the drive shaft.

21. The window covering drive system of claim 15, wherein the drive component further comprises a drive belt and a belt tensioning mechanism that provides pre-tension in the belt and sustains tension during operation of the drive system.

22. The window covering drive system of claim 21, wherein the drive belt comprises two ends and wherein the belt tensioning mechanism comprises belt clamps connecting the two belt ends and a spring applying tension between the two belt ends.

23. The window covering drive system of claim 22, wherein the drive component further comprises a limiter that limits a gap between the two belt ends, such that initial motion of the drive belt is pulled about a pair of pulleys to reduce slack and maintain tension in the drive belt.

24. The window covering drive system of claim 21, wherein the operator assembly comprises a sled that slides within a channel in the sash frame and an operator handle coupled to the sled and positioned on the sash frame for use by an operator, with the sled coupled to the drive component, such that sliding movement of the operator handle by an operator results in sliding movement of the sled and actuation of the drive component for operation of the window covering, and wherein the drive belt comprises two ends and the belt tensioning mechanism comprises belt clamps connecting the two belt ends and a spring applying tension between the two belt ends, and wherein the sled is configured to slidably receive the spring clamp with the operator handle configured to serve as a limiter that limits a gap between the two belt ends, such that initial motion of the operator handle does not produce motion of the drive belt until the belt clamp engages the sled resulting in the drive belt being pulled about a pair of pulleys to reduce slack and maintain tension in the drive belt.

25. The window covering drive system of claim 15 in combination with a window or window sash including the sash frame and a glazing panel mounted therein.

26. The window covering drive system of claim 25, wherein the sash frame is openable with respect to the window or window sash and wherein the sash frame comprises an opening restrictor mounted to the openable sash frame on one end and to the window or window sash on the other end that restricts the openability of the openable sash frame.

27. The window or sash of claim 26, wherein the openable sash frame rotates to swing open and shut with respect to the window or window sash, and wherein the opening restrictor comprises:

a first cord anchor mounted to the openable sash frame;

a second cord anchor mounted to the window or window sash;

a spring anchor mounted to the openable sash frame at an opposite end than the first cord anchor;

a slider slidably mounted to the openable sash frame between the first cord anchor and the spring anchor and resiliently coupled to the spring anchor by a resilient member; and

a cord connected to the first cord anchor at a first cord end, routed around the slider and connected to the second cord anchor at a second cord end,

such that opening movement of the openable sash frame results in extension of the cord away from the window or window sash with a corresponding movement of the slider toward the first cord anchor and away from the spring anchor causing an extension of the resilient member.

28. A window covering drive system mountable in a sash frame for use in operating a window covering mounted to the sash frame, the drive system comprising:

a window covering operating mechanism configured to operate the window covering through actuation of a lift cord, the operating mechanism including a drive shaft and a lift spool assembly coupled to the drive shaft, the lift spool assembly including a rotatable lift spool having first and second ends and a varying diameter with the diameter decreasing from the first and second ends toward a middle, the lift spool attached to a first end of the lift cord and configured to receive the lift cord in a series of coils when the lift spool rotates in a first direction;

a drive component coupled to the drive shaft of the window covering operating mechanism; and

an operator assembly slidably mounted to the sash frame and coupled to the drive component, such that linear motion of the operator assembly results in rotary action of a portion of the drive component to rotate the drive shaft and operate the window covering operating mechanism.

29. The window covering drive system of claim 28, wherein the lift spool assembly further comprises a housing supporting the lift spool, the housing including an angled surface positioned to engage the lift cord as it first winds about the lift spool at the second end of the lift spool and to urge the lift cord coil away from the second end toward the middle of the spool so as to make room for a subsequent coil of the lift cord as the lift spool continues to rotate.

30. The window covering drive system of claim 29, wherein rotation of the lift spool in a second direction results in uncoiling of the lift cord from about the lift spool.
31. The window covering drive system of claim 28, wherein the drive component further comprises a drive belt and a belt tensioning mechanism that provides pre-tension in the belt and sustains tension during operation of the drive system.

32. The window covering drive system of claim 31, wherein the drive belt comprises two ends and wherein the belt tensioning mechanism comprises a spring clamp connecting the two belt ends and applying tension between the two belt ends, the spring clamp including two belt clamps attached to the two belt ends, respectively, and a spring connected between the two belt clamps.

33. The window covering drive system of claim 32, wherein the drive component further comprises a limiter that limits a gap between the two belt ends, such that initial motion of the operator handle does not produce motion of the drive belt until the limiter is engaged and such that the drive belt is pulled about a pair of pulleys to reduce slack and maintain tension in the drive belt.

34. The window covering drive system of claim 31, wherein the operator assembly comprises a sled that slides within a channel in the sash frame and an operator handle coupled to the sled and positioned on the sash frame for use by an operator, with the sled coupled to the drive component, such that sliding movement of the operator handle by an operator results in sliding movement of the sled and actuation of the drive component that operates the window covering, and wherein the drive belt comprises two ends and the belt tensioning mechanism comprises a spring clamp connecting the two belt ends and applying tension between the two belt ends, and wherein the sled is configured to slidably receive the spring clamp and the operator handle is configured to serve as a limiter that limits a gap between the two belt ends, such that initial motion of the operator handle does not produce motion of the drive belt until the spring clamp engages the sled such that the drive belt is pulled about a pair of pulleys to reduce slack and maintain tension in the drive belt.

35. The window covering drive system of claim 28, wherein the sash frame comprises a plurality of members configured to connect at corners of the sash frame and further comprising a corner lock configured to attach to and connect two adjoining frame members at the corner of the sash frame, the corner lock including a recess formed to receive and couple to a portion of the drive component.

36. The window covering drive system of claim 35, wherein the drive component comprises a drive belt and first and second pulleys about which the drive belt is positioned, with the first pulley received within the recess of the corner lock and a portion of the drive belt passing within the recess and about the first pulley.

37. The window covering drive system of claim 28 in combination with a window or window sash including the sash frame and a glazing panel mounted therein.

38. The window covering drive system of claim 37, wherein the sash frame is operable with respect to the window or window sash and wherein the sash frame comprises an opening restrictor mounted to the openable sash frame on one end and to the window or window sash on the other end that restricts the openability of the openable sash frame.

39. The window or sash of claim 38, wherein the openable sash frame rotates to swing open and shut with respect to the window or window sash, and wherein the opening restrictor comprises:

a first cord anchor mounted to the openable sash frame;

a second cord anchor mounted to the window or window sash;

a spring anchor mounted to the openable sash frame at an opposite end than the first cord anchor;

a slider slidably mounted to the openable sash frame between the first cord anchor and the spring anchor and resiliently coupled to the spring anchor by a resilient member; and

a cord connected to the first cord anchor at a first cord end, routed around the slider and connected to the second cord anchor at a second cord end,

such that opening movement of the openable sash frame results in extension of the cord away from the window or window sash with a corresponding movement of the slider toward the first cord anchor and away from the spring anchor causing an extension of the resilient member.

40. A method of operating a window covering mounted to a sash frame, the sash frame including a drive system coupled to the window covering and a handle coupled to the sash frame and to the drive system, the method comprising the steps of:

sliding the handle along a portion of the sash frame;

engaging the handle with the drive system;

moving a portion of the drive system by continued sliding of the handle resulting in rotation of a drive component operationally coupled between the window covering and the drive system; and

adjusting the window covering in a desired manner including at least one of extending, contracting, tilting open and tilting closed by movement of the handle.

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