elements in an assembly having limited space for accommodating the additional locking elements.

SUMMARY

[0005] The following presents a simplified summary in order to provide a basic understanding of some aspects described herein. This summary is not an extensive overview of the claimed subject matter. It is intended to neither identify key or critical elements of the claimed subject matter nor delineate the scope thereof. Its sole purpose is to present some concepts in a simplified form as a prelude to the more detailed description that is presented later.

[0006] Increasing the number of supplemental locking elements on a key blade with a movable element would increase the number of unique key possibilities, reduce the ability to pick the lock, and retain control of key blade distribution with the manufacturer.

[0006a] According to an aspect, the present disclosure refers to a key blank to be formed into a key for operating a lock comprising a housing, a plug with a keyway formed therein, wherein the plug is rotatably disposed within a bore formed in the housing, a sidebar disposed within a sidebar opening formed in the plug and configured for radial movement with respect to an axis of rotation of the plug for engaging a sidebar groove formed in a wall of the bore formed in the housing for controlling rotation of the plug within the housing, primary pin assemblies aligned with the keyway for controlling rotation of the plug within the housing and for controlling radial movement of the sidebar within the sidebar opening, one or more secondary pins disposed adjacent the keyway for controlling radial movement of the sidebar within the sidebar opening, and at least one supplemental sidebar control element for controlling radial movement of the sidebar within the sidebar opening, the key blank comprising a key blade configured to be inserted into the keyway of the lock, the key blade comprising: a primary top edge, wherein the primary top edge is configured to receive primary bittings cut therein for controlling the primary pin assemblies of the lock when a key formed from the key blank is inserted into the keyway; a bottom edge; first and second opposed sides extending between the primary top edge and the bottom edge; wherein the first side includes a rib extending

longitudinally along at least a portion of the length of the key blade, the rib having a secondary top edge, wherein the secondary top edge is configured to receive secondary bittings cut therein for controlling the secondary pins of the lock when a key formed from the key blank is inserted into the keyway; and wherein the second side includes a groove opposite the rib and extending longitudinally along at least a portion of the length of the key blade; and at least one movable element disposed within the key blade, wherein the movable element is configured to engage a multi-level ridge projecting from a side of the keyway and aligned with the groove as a key formed from the key blank is inserted into the keyway to move the movable element from a first position, where a second portion of the movable element extends into the groove, to a second position, where the second portion of the movable element is moved out of the groove and a first portion of the movable element extends from the first side of the key blade to actuate the supplemental sidebar control element.

[0006b] According to another aspect, the present disclosure refers to a key formed from the key blank of the above aspect and further comprising primary bittings cut into the primary top edge for controlling the primary pin assemblies of the lock when the key is inserted into the keyway, and secondary bittings cut into the secondary top edge for controlling the secondary pins of the lock when the key is inserted into the keyway.

[0006c] According to another aspect, the present disclosure refers to a lock assembly comprising: a housing; a plug with a keyway formed therein, wherein the plug is rotatably disposed within a bore formed in the housing; a sidebar disposed within a sidebar opening formed in the plug and configured for radial movement with respect to an axis of rotation of the plug for engaging a sidebar groove formed in a wall of the bore formed in the housing for controlling rotation of the plug within the housing; primary pin assemblies aligned with the keyway and configured to be contacted by primary bittings of a key blade for controlling rotation of the plug within the housing and radial movement of the sidebar within the sidebar opening; one or more secondary pins disposed adjacent the keyway and configured to be contacted by secondary bittings of the key blade for controlling radial movement of the sidebar within the sidebar opening wherein each secondary pin comprises a transversely extending projection extending into the keyway to be contacted by a secondary bitting of the key blade; a multi-level ridge projecting from a side of the keyway and extending longitudinally along at least a portion

of the length of the side of the keyway, wherein the multi-level ridge is configured to engage at least one shuttle pin disposed within the key blade inserted into the keyway, wherein the shuttle pin is configured for movement within the key blade between a retracted position in which one end of the shuttle pin is retracted with respect to a side of the key blade opposite the multi-level ridge, to an extended position, in which the end of the shuttle pin is extended from a side of the key blade opposite the multi-level ridge, and wherein the multi-level ridge comprises: a first level extending from a front end of the keyway and configured to provide clearance for the shuttle pin located in the retracted position to enter the keyway within the key blade; a second level located further from the front end of the keyway than the first level, projecting further from the side of the keyway than the first level, and configured to be contacted by the shuttle pin to position the shuttle pin in the extended position with the end of the shuttle pin extending into a relief formed in a side of the keyway opposite the second level; a third level located further from the front end of the keyway than the second level, projecting further from the side of the keyway than the second level, and configured to engage a groove of the key blade; a first transition ramp contiguous with the first level and the second level and configured to move the shuttle pin from the retracted position to the extended position; and a second transition ramp contiguous with the second level and the third level and configured to block the shuttle pin from progressing past the second level; and at least one supplemental sidebar control element disposed adjacent the keyway opposite the first transition ramp and configured to be contacted by a shuttle pin of the key blade moved to the extended position by the first transition ramp to actuate movement of the supplemental sidebar control element for controlling radial movement of the sidebar within the sidebar opening, wherein the supplemental sidebar control element includes a shuttle pin engaging portion disposed within the relief formed in the keyway and laterally offset from the transversely extending projection of each secondary pin so that the supplemental sidebar control element is contacted by the shuttle pin in the extended position extending from the key into the relief but is not contacted by the secondary bittings of the key.

[0006d] According to another aspect, the present disclosure refers to a plug assembly for a lock assembly, the plug assembly comprising: a plug configured to be rotatably disposed within a bore of a housing; a keyway formed in the plug and shaped to receive a correspondingly-shaped key blade of a key and having a width extending laterally from a first side of the keyway to an opposing second side of the keyway; a sidebar disposed within a sidebar opening formed in

the plug and configured for radial movement with respect to an axis of rotation of the plug for engaging a sidebar groove formed in a wall of the bore formed in the housing for controlling rotation of the plug within the housing; primary pin assemblies aligned with the keyway and configured to be contacted by primary bittings of the key blade for controlling rotation of the plug within the bore and radial movement of the sidebar within the sidebar opening; one or more secondary pins disposed adjacent the keyway and configured to be contacted by secondary bittings of the key blade for controlling radial movement of the sidebar within the sidebar opening, wherein each secondary pin comprises a transversely extending projection extending into the keyway to be contacted by a secondary bitting of the key blade; at least one sidebar control element disposed adjacent the keyway and configured to be contacted by a shuttle pin of the key for controlling movement of the sidebar control element between a locked state blocking radial movement of the sidebar within the sidebar opening and an unlocked state permitting radial movement of the sidebar within the sidebar opening, wherein the sidebar control element includes a shuttle pin engaging portion that is laterally offset from the transversely extending projection of each secondary pin so that the sidebar control element is contacted by the shuttle pin extending from the key but is not contacted by the secondary bittings of the key, a multi-level ridge projecting from the second side of the keyway and extending longitudinally along at least a portion of the length of the second side of the keyway, wherein the multi-level ridge is configured to engage at least one shuttle pin disposed within the key blade inserted into the keyway, wherein the shuttle pin is configured for movement within the key blade between a retracted position in which one end of the shuttle pin is retracted with respect to a side of the key blade opposite the multi-level ridge, to an extended position, in which the end of the shuttle pin is extended from side of the key blade opposite the multi-level ridge to actuate movement of the sidebar control element from the locked state to the unlocked state, and wherein the multi-level ridge comprises: a first level extending from a front end of the keyway and configured to provide clearance for the shuttle pin in the retracted position within the key blade to enter the keyway; a second level located further from the front end of the keyway than the first level, projecting further from the second side of the keyway than the first level, located opposite to the sidebar control element, and configured to be contacted by the shuttle pin to position the shuttle pin in the extended position with the end of the shuttle pin extending into a relief formed in the first side of the keyway opposite the second level; a third level located further from the front end of

the keyway than the second level, projecting further from the second side of the keyway than the second level, and configured to engage a groove of the key blade; a first transition ramp contiguous with the first level and the second level and configured to move the shuttle pin from the retracted position to the extended position; and a second transition ramp contiguous with the second level and the third level and configured to block the shuttle pin from progressing past the second level.

[0006e] According to another aspect, the present disclosure refers to a lock assembly comprising a housing; a plug rotatably disposed within a bore formed in the housing; a keyway formed within the plug, shaped to receive a correspondingly-shaped key blade, and having a length extending longitudinally through the plug and a width extending laterally from a first side of the keyway to an opposing second side of the keyway; a sidebar disposed within a sidebar opening formed in the plug and configured for radial movement with respect to an axis of rotation of the plug for engaging a sidebar groove formed in a wall of the bore formed in the housing for controlling rotation of the plug within the housing; and a first sidebar control element and a second sidebar control element disposed within the plug on the first side of the keyway, wherein the first and second sidebar control elements are configured for movement between a locked state blocking radial movement of the sidebar within the sidebar opening and an unlocked state permitting radial movement of the sidebar within the sidebar opening, a multi-level ridge projecting from the second side of the keyway and extending longitudinally along at least a portion of the length of the second side of the keyway, wherein the multi-level ridge is configured to engage a first shuttle pin and a second shuttle pin disposed within the key blade inserted into the keyway, wherein the first shuttle pin is configured for movement within the key blade between a first position, in which a second end of the first shuttle pin extends into a groove formed in a side of the key blade, to a second position, in which the second end of the first shuttle pin is moved out of the groove and a first end of the first shuttle pin extends from the first side of the key blade to actuate movement of the first sidebar control element from the locked state to the unlocked state, and the second shuttle pin is configured for movement within the key blade between a first position, in which a second end of the second shuttle pin extends into the groove, to a second position, in which the second end of the second shuttle pin is moved out of the groove and a first end of the second shuttle pin extends from the first side of the key blade to actuate movement of the second sidebar control element from the locked state to the unlocked

state, and wherein the multi-level ridge comprises: a first section comprising: a first section first level extending from a front end of the keyway and configured to provide clearance for the first shuttle pin in the first position within the key blade and the second shuttle pin in the first position within the key blade to enter the keyway; a first section second level located further from the front end of the keyway than the first section first level, wherein the first section second level projects further from the second side of the keyway than the first section first level, is located opposite to the first sidebar control element, and is configured to be contacted by the first shuttle pin to position the first shuttle pin in the second position with the first end of the first shuttle pin extending into a first relief formed in the first side of the keyway opposite the first section second level; a first section first transition ramp contiguous with the first section first level and the first section second level and configured to move the first shuttle pin and second shuttle pin from the first position to the second position as the key blade is inserted into the keyway; and a regression ramp contiguous with the first section second level and configured to move the second shuttle pin from the second position to the first position as the key blade is inserted into the keyway; and a second section located further from the front end of the keyway than the first section, and comprising: a second section first level configured to provide clearance for the second shuttle pin located in the first position within the key blade to enter the second section; a second section second level located further from the front end of the keyway than the second section first level, wherein the second section second level projects further from the second side of the keyway than the second section first level, is located opposite to the second sidebar control element, and is configured to be contacted by the second shuttle pin to position the second shuttle pin in the second position with the first end of the second shuttle pin extending into a second relief formed in the first side of the keyway opposite the second section second level; a third level located further from the front end of the keyway than the second section second level, projecting further from the second side of the keyway than the second section second level, and configured to engage the groove of the key blade; a second section first transition ramp contiguous with the second section first level and the second section second level and configured to move the second shuttle pin from the first position to the second position as the key blade is inserted into the keyway; and a second transition ramp contiguous with the second section second level and the third level and configured to block the second shuttle pin from progressing past the second section second level and to prevent the key blade from further insertion.

[0007] Examples of the disclosed subject matter are embodied in keys, key blanks, keyways, and lock cylinders. The lock generally comprises a housing and a plug with a keyway formed therein. The plug is rotatably disposed within a bore formed in the housing. A sidebar is disposed within a sidebar opening formed in the plug and configured for radial movement with respect to an axis of rotation of the plug for engaging a sidebar groove formed in a wall of the bore formed in the housing for controlling rotation of the plug within the housing. Primary pins or primary side bar control elements (rotating tumblers) are aligned with the keyway for controlling rotation of the plug within the housing and for controlling radial movement of the sidebar within the sidebar opening. One or more secondary pins or secondary sidebar control elements are disposed within the plug adjacent to the keyway for controlling radial movement of the sidebar within the sidebar opening. At least one supplemental sidebar control element for further controlling radial movement of the sidebar is disposed within the sidebar opening.

[0008] In various examples, the keyway of the cylinder lock may include a multi-level ridge or rib that has multiple lengthwise segments or extents of different heights (i.e., different levels, planes, or surfaces) along the length of the ridge and transitions (transition zone or ramps) between the different segments. These surfaces of these different segments may interact with one or more moveable element(s) (e.g., shuttle pin(s)) in the key to thereby move

each moveable element into position to engage and control locking element(s) in the cylinder. The multi-level ridge's different levels may be located at different positions along the length of the keyway to align with different key and cylinder adaptations.

[0009] The key blank has a key blade configured to be inserted into a keyway of the lock. In various examples, the key blade has a primary top edge configured to receive primary bittings cut therein for controlling the primary pins of the lock when a key formed from the key blank is inserted into the keyway, a bottom edge, and first and second opposed sides extending between the primary top edge and the bottom edge. The first side includes a rib that extends longitudinally along at least a portion of the length of the key blade. The rib has a secondary top edge configured to receive secondary bittings cut therein for controlling the secondary pins of the lock when a key formed from the key blank is inserted into the keyway. A groove may be formed on the second side of the key blade to align with the multi-level ridge and to allow the shuttle pin to engage the multi-level ridge as the key is inserted. A shuttle pin is disposed within a through-hole extending through the key blade from the first side to the second side. The shuttle pin is configured to engage the multi-level ridge within the keyway as a key formed from the key blank is inserted into the keyway to move the shuttle pin between a retracted position in which one end of the shuttle pin is retracted with respect to the first side of the key blade opposite the multi-level ridge, to an extended position, in which the end of the shuttle pin is extended from the first side of the key blade opposite the multi-level ridge to actuate movement of the sidebar control element from a locked state to an unlocked state.

[0010] In various examples, the key has a key blade configured to be inserted into a keyway of the lock. The key blade may include a primary top edge configured with a first bitting surface cut therein for controlling the primary pins of the lock when the key is inserted into the keyway, a bottom edge, and first and second opposed sides extending between the primary top edge and the bottom edge. The key blade may further include a rib extending longitudinally along at least a portion of the length of the key blade. The rib has a secondary top edge, wherein the secondary top edge is configured with a second bitting surface cut therein for controlling the secondary pins of the lock when the key is inserted into the keyway. The key blade further includes a groove formed in the second side opposite the rib and extending longitudinally along at least a portion of the length of the key blade. The key blade may further

350. As a torque is applied to the key 110, the sidebar 328 may move radially into the plug 354, with the third cutout portion 350 receiving the blocking lug 320, as shown in FIG. 35c. The third cutout portion 350 is sufficiently deep to enable the sidebar 328 to move radially inward. As the sidebar 328 moves radially inward, the beveled projection 342 withdraws from the axial groove 156 and permits the plug 354 to rotate within the housing 152.

[00169] As the key blade 116 is removed from the plug 354, the extended end 142 of the shuttle pin 138 engages third transition feature 275 opposite the multi-level ridge 164. The third transition feature 275 moves the shuttle pin 138 from a position previously determined by the second level 268 back to a position primarily contained within the key blade 116 groove 127 at the first level 266. Movement of the shuttle pin 138 back to the retracted positions allows clearance for shuttle pin 138 in the keyway 356 as the key blade 116 is removed.

[00170] In an alternate embodiment, the sidebar includes a protruding blocking lug and the slider includes a lug-receiving recess (not shown) Movement of the slider from a locked state or position to an unlocked state or position comprises engaging the slider with the shuttle pin as described above to move the slider from a first position, in which the lug-receiving recess is not aligned with the blocking lug of the sidebar so that the blocking lug contacts the slider to prevent lateral (e.g., radial) movement of the sidebar within the sidebar cavity, to a second position, in which the lug-receiving recess is aligned with the blocking lug of the sidebar so that the blocking lug can enter the lug-receiving recess to permit lateral (e.g., radial) movement of the sidebar within the sidebar cavity.

Lock Assembly - Third Embodiment

[00171] FIG. 37 illustrates a third embodiment of a lock assembly 500. As with lock assembly 100, described above, lock assembly 500 includes housing 152 having axial bore 154 in which a cylindrical plug 562, having a longitudinally-extending keyway 564, is rotatably disposed. Primary pin sets 186, as described above, control rotation of the plug 562 within the bore 154 and secondary pins 204, as described above, are positioned by the secondary bitting cuts 136 of key 110. Lock assembly 500, includes a side bar 536 disposed within a sidebar cavity 566 formed in plug 562 and is operable to engage a sidebar groove 156 formed in the wall of bore 154 as described above. Sidebar 536 includes a beveled nose 550 that engages the sidebar

groove 156. The lock assembly 500 includes a supplemental sidebar control element comprising a supplemental pin, e.g., in the form of a flipper pin 502 rotationally oriented by shuttle pin 138 of key 110 to control movement of the sidebar 536 out of engagement with the sidebar groove 156, as will be described below.

[00172] As shown in FIGS. 4A-4D, the shuttle pin 138 can be positioned at varying longitudinal positions along the length of the blade 116a-116d to accommodate various numbers and arrangements of the supplemental sidebar control element. In some embodiments, the lock assembly may have no secondary pins. In various embodiments, the sidebar may be controlled by only one or more supplemental sidebar control elements (e.g., one or more flipper pins), or by any combination of primary pins, secondary pins, and supplemental sidebar control elements.

[00173] FIGS. 40 and 41 illustrate features of one embodiment of the sidebar 536. Similar to sidebar 222 in lock assembly 100, sidebar 536 has various blocking elements to block the sidebar 536 from moving radially when the lock assembly 500 is in the locked state and allow radial movement of the sidebar 536 when the lock assembly 500 is in the unlocked state. The sidebar 536 includes primary pin blocking lugs 544 projecting from a second side 542 of the sidebar 536, secondary pin cutouts 546 formed in the second side 542 between adjacent pairs of blocking lugs 544, secondary pin blocking shelves 548 (e.g., curved) extending across each cutout 546, and a supplemental blocking feature, such as a flipper pin cutout 538. The flipper pin cutout 538 is a cutout that received a portion of the flipper pin 502 in the unlocked state after the shuttle pin 138 rotates the flipper 502. As shown in FIG. 47A, the flipper pin cutout 538 includes first and second initial cutouts 535, 537 extending from the second side 542 of the sidebar 536, and a center cutout 539 between the initial cutouts 535, 537 and extending deeper into the sidebar 536 than the initial cutouts 535, 537.

[00174] FIGS. 38A and 38B depict one embodiment of the flipper pin 502. The flipper pin 502 has a body 504, which is generally cylindrical in shape. On a first side 506 of the flipper pin 502 near a bottom end 512, a transversely extending shuttle pin engaging portion (lobe, or flipper) 522 extends into the keyway 564 to be engaged by shuttle pin 138 on key blade 116. The flipper 522 is laterally offset from a transversely extending projection 212 of the side pin(s) 204, and thus the flipper 522 is not engaged or contacted by secondary cuts 136 of the rib 132 on

shown within the keyway 564 as it would be positioned by the shuttle pin 138 of a key 110 inserted into the keyway 564. To illustrate the manipulation of the shuttle pin 138 more clearly, the key 110 is omitted from FIGS. 43A and 43B.

[00178] Referring to FIG. 43A, as the key (not shown) is inserted into the keyway 564, the shuttle pin 138 travels through the keyway 564 to a first position. In the first position, as shown in FIG. 44, the second end 144 of the shuttle pin 138 extends into a groove 127 on the second side 126 of the key blade 116. The flipper pin 502 is in a spring-biased resting position where sidebar engagement lug 528 on the top end 510 does not align with the flipper pin cutout 538 on the sidebar 536, and the sidebar 536 is prevented from moving radially inwardly to retract from the groove 156.

[00179] Referring to FIG. 43B, as the key 110 continues through the keyway 564 in the insertion direction A, the shuttle pin 138 engages a first transition ramp 272 of the multi-level ridge 164 extending into the groove 127 in the key blade 116 and moves from a first level 266 to a second level 268 of the multi-level ridge 164. Positioning the shuttle pin 138 at the second level 268 of the multi-level ridge 164 pushes the shuttle pin 138 into a shuttle pin relief 568 formed in the keyway 564 opposite the multi-level ridge 164. In this position, the enlarged first end 142 of the shuttle pin 138 extends out of the first side 124 of the key blade 116 (*see* FIG. 45), and contacts the flipper 522 that is rotated into the relief 568. As the key 110 moves forward into a fully inserted position, the second end 144 of the shuttle pin 138 continues up the multi-level ridge 164 and moves the shuttle pin 138 forward to rotate the flipper 522 into the flipper recess 532 in the flipper hole 530, thereby rotating the flipper pin 502. In the rotated position, the sidebar engagement lug 528 of the flipper pin 502 is now aligned with center cutout 539 of the flipper cutout 538 on the sidebar 536. This is illustrated in FIGS. 47B and 47C. In FIG. 47B, with the flipper pin 502 rotationally biased into a locked orientation, the sidebar engagement lug 528, is oriented transversely to the center cutout 539 of the flipper cutout 538. Thus, the initial cutouts 535, 537 of the flipper cutout 538 contact the flipper pin 502, thereby blocking radial movement of the sidebar 536. In FIG. 47C, the flipper pin 502 is rotated by the shuttle pin 138 of the inserted key 110 into an unlocked orientation, the side bar engagement lug 528 is aligned with the center cutout 539 of the flipper cutout 538, and the sidebar 536 is able to move radially into an unlocked position.

supplemental sidebar control elements.

[00192] FIG. 51 shows one embodiment of a sidebar 710 corresponding to lock assembly 700 having first lift pin 238a and second lift pin 238b. Similar to sidebar 222 in lock assembly 100, the sidebar 710 has first side 223 having beveled projection or nose 232 and a second side 225 having various blocking elements to block the sidebar 710 from moving radially when the lock assembly 700 is in the locked state and allow radial movement of the sidebar 710 when the lock assembly 700 is in the unlocked state. The sidebar 710 includes primary pin blocking lugs 224, secondary cutouts 226 formed in the second side 225 between adjacent pairs of blocking lugs 224, and secondary blocking shelves 228 extending across each cutout 226. Sidebar 710 further includes a first supplemental cutout 256a and first supplemental blocking shelf 258a extending across cutout 256a to correspond with first lift pin 238a, and second supplemental cutout 256b and second supplemental blocking shelf 258b extending across cutout 256b to correspond with second lift pin 238b.

[00193] FIG. 52 shows the keyway 702 within the plug 712 having a multi-level ridge 704, first lift pin 238a disposed in first lift pin hole 262a, and a second lift pin 238b disposed in second lift pin hole 262b. Lift pin 238a is shown within the keyway 702 as it would be positioned by shuttle pin 138a of key blade 117, and lift pin 238b is shown within the keyway 702 as it would be positioned by the shuttle pin 138b of key blade 117. To illustrate the manipulation of the shuttle pin 138a and shuttle pin 138b more clearly, the key blade 117 is omitted from FIG. 52.

[00194] As shown in FIG. 52, first lift pin 238a has a shuttle pin cutout 240a and a downwardly pointing beveled edge 260a on a first side and a transverse sidebar slot (not shown) on a second side. Second lift pin 238b has a shuttle pin cutout 240b and a downwardly pointing beveled edge 260b on a first side and a transverse sidebar slot (not shown) on a second side. *See also* FIGS. 15A, 15B, 15C.

[00195] Multi-level ridge 704 is designed with transition ramps and levels to support two shuttle pins in a single key interacting with two lift pins in a single keyway. Multi-level ridge 704 may be referred to as having two sections – a first section 704a corresponding to lift pin 238a and shuttle pin 138a and a second section 704b corresponding to lift pin 238b and shuttle

pin 138b when key blade 117 is fully inserted. Lift pin 238a is in position one (i.e., a first location of four possible supplemental locking element locations in plug 712) and closest to a front end 280 of keyway 702. The first section 704a of multi-level ridge 704 is on a side (second side) 716 of the keyway 702 opposite lift pin 238a. Lift pin 238b is in position three (i.e., a third location of four possible supplemental locking element locations in plug 712) and is the furthest supplemental sidebar locking element from the front end 280 of keyway 702. The second section 704b of multi-level ridge 704 is on the side 716 of the keyway 702 opposite lift pin 238b. In various embodiments, the second section 704b may be in any location along the length of keyway 702 on side 716 opposite the furthest supplemental sidebar locking element from the front end 280. The first section 704a may be in multiple locations and in any location along the length of the keyway on side 716 opposite a supplemental sidebar control element located before the second section 704b (i.e., located before the furthest supplemental sidebar locking element from the front end).

[00196] As the key blade 117 is inserted into keyway 702, multi-level ridge 704 first section 704a engages and moves shuttle pin 138b across the width of the key blade 117 to engage lift pin 238a on an opposite side (first side) 714 of the keyway 702. As the key blade 117 continues through the keyway 704, shuttle pin 138b disengages from lift pin 238a and moves away from multi-level ridge 704 first section 704a to multi-level ridge 704 second section 704b. The multi-level ridge 704 first section 704a then engages and moves shuttle pin 138a across the width of the key blade 117 to engage lift pin 238a on opposite side 714 of the keyway 702. Concurrently, multi-level ridge 704 second section 704b engages and moves shuttle pin 138b across the width of the key blade 117 to engage lift pin 238b on side 714 of the keyway 702. For the key blade 117 to successfully unlock the lock 700, a correct alignment of both shuttle pin 138a with lift pin 238a and shuttle pin 138b with lift pin 238b must occur. When key blade 117 is fully inserted into the keyway 702, the first section 704a of multi-level ridge location along the length of the cylinder keyway 702 corresponds to the location of lift pin 238a in the keyway 702 and shuttle pin 138a in the key blade 117, and the second section 704b of multi-level ridge location corresponds to the location of lift pin 238b in the keyway 702 and shuttle pin 138b in the key blade 117.

[00197] Referring to FIG. 52, the first section 704a of multi-level ridge is similar to the multi-level ridge 164 described above in connection with lock 100 except the first section 704a

702.

[00205] Referring to FIG. 52, as the key blade 117 is inserted into the keyway 702, second shuttle pin 138b travels through the keyway 702 to the first level 266a of multi-level ridge 704 first section 704a. At this point, a second end 144b of shuttle pin 138b extends into groove 127 on the second side 126 of the key blade 117. The first lift pin 238a and second lift pin 238b are in a resting position where sidebar slots 242 on first lift pin 238a and second lift pin 238b are not aligned with supplemental blocking shelf 258a and supplemental blocking shelf 258b, respectively, and the sidebar 710 is prevented from moving radially inwardly to retract from the groove 156.

[00206] As the key blade 117 is inserted further into the keyway 702, the first transition ramp 272a engages the second end 144b of shuttle pin 138b (i.e., the second shuttle pin 138b contacts the first transition ramp 272a) in the key blade 117 groove 127 and moves shuttle pin 138b from the first level 266a to the second level 268a of the multi-level ridge 704 first section 704a. Positioning the shuttle pin 138b to the second level 268a of the first section 704a moves the shuttle pin 138b across the width of key blade 117, into relief 165a formed in the keyway 162, to properly engage the first lift pin 238a in the cylinder 712. In this position, the sidebar slot 242 on the first lift pin 238a is aligned with supplemental blocking shelf 258a, but second lift pin 238b remains in a resting position where sidebar slots 242 on second lift pin 238b are not aligned with supplemental blocking shelf 258b. The sidebar 710 is prevented from moving radially inwardly to retract from the groove 156.

[00207] As the key blade 117 moves forward, shuttle pin 138b disengages lift pin 238a and continues traveling in the insertion direction A at a position or height within the keyway 702 determined by the second level 268a. The extended end 142b of shuttle pin 138b contacts the fourth transition feature 708 opposite the multi-level ridge 704. The fourth transition feature 708 moves the shuttle pin 138b from the position previously determined by the second level 268a to the regression ramp 706 and to a position primarily contained within the key blade 117 groove 127 at the first level 266b of second section 704b. Movement of the second shuttle pin 138b back to the retracted position allows clearance for shuttle pin 138b in the keyway 702 as the key blade 117 continues traveling in the insertion direction.

CLAIMS

1. A key blank to be formed into a key for operating a lock comprising a housing, a plug with a keyway formed therein, wherein the plug is rotatably disposed within a bore formed in the housing, a sidebar disposed within a sidebar opening formed in the plug and configured for radial movement with respect to an axis of rotation of the plug for engaging a sidebar groove formed in a wall of the bore formed in the housing for controlling rotation of the plug within the housing, primary pin assemblies aligned with the keyway for controlling rotation of the plug within the housing and for controlling radial movement of the sidebar within the sidebar opening, one or more secondary pins disposed adjacent the keyway for controlling radial movement of the sidebar within the sidebar opening, and at least one supplemental sidebar control element for controlling radial movement of the sidebar within the sidebar opening, the key blank comprising a key blade configured to be inserted into the keyway of the lock, the key blade comprising:

a primary top edge, wherein the primary top edge is configured to receive primary bittings cut therein for controlling the primary pin assemblies of the lock when a key formed from the key blank is inserted into the keyway;

a bottom edge;

first and second opposed sides extending between the primary top edge and the bottom edge;

wherein the first side includes a rib extending longitudinally along at least a portion of the length of the key blade, the rib having a secondary top edge, wherein the secondary top edge is configured to receive secondary bittings cut therein for controlling the secondary pins of the lock when a key formed from the key blank is inserted into the keyway; and

wherein the second side includes a groove opposite the rib and extending longitudinally along at least a portion of the length of the key blade; and

at least one movable element disposed within the key blade,

wherein the movable element is configured to engage a multi-level ridge projecting from a side of the keyway and aligned with the groove as a key formed from the key blank is inserted into the keyway to move the movable element from a first position, where a second portion of the movable element extends into the groove, to a second position, where the second portion of

the movable element is moved out of the groove and a first portion of the movable element extends from the first side of the key blade to actuate the supplemental sidebar control element.

2. The key blank of claim 1, wherein the movable element comprises a shuttle pin disposed within a through-hole extending through the key blade from the first side to the second side, and wherein the shuttle pin comprises a first head portion, a second head portion, and a center portion connecting the first head portion to the second head portion, wherein the first head portion and the second head portion are wider than the center portion.

3. The key blank of claim 2, further comprising a shuttle pin retainer disposed within a retainer hole formed in the key blade, wherein the shuttle pin retainer intersects the through hole between the first head portion and the second head portion of the shuttle pin.

4. The key blank of claim 2 or 3, wherein the shuttle pin extends through the rib.

5. A key formed from the key blank of any one of claims 1 to 4 and further comprising

primary bittings cut into the primary top edge for controlling the primary pin assemblies of the lock when the key is inserted into the keyway, and

secondary bittings cut into the secondary top edge for controlling the secondary pins of the lock when the key is inserted into the keyway.

6. The key of claim 5, wherein the primary bittings are skew type bittings configured to elevate and rotate the primary pin assemblies.

7. A lock assembly comprising:

a housing;

a plug with a keyway formed therein, wherein the plug is rotatably disposed within a bore formed in the housing;

a sidebar disposed within a sidebar opening formed in the plug and configured for radial movement with respect to an axis of rotation of the plug for engaging a sidebar groove formed in a wall of the bore formed in the housing for controlling rotation of the plug within the housing;

primary pin assemblies aligned with the keyway and configured to be contacted by primary bittings of a key blade for controlling rotation of the plug within the housing and radial movement of the sidebar within the sidebar opening;

one or more secondary pins disposed adjacent the keyway and configured to be contacted by secondary bittings of the key blade for controlling radial movement of the sidebar within the sidebar opening wherein each secondary pin comprises a transversely extending projection extending into the keyway to be contacted by a secondary bitting of the key blade;

a multi-level ridge projecting from a side of the keyway and extending longitudinally along at least a portion of the length of the side of the keyway, wherein the multi-level ridge is configured to engage at least one shuttle pin disposed within the key blade inserted into the keyway, wherein the shuttle pin is configured for movement within the key blade between a retracted position in which one end of the shuttle pin is retracted with respect to a side of the key blade opposite the multi-level ridge, to an extended position, in which the end of the shuttle pin is extended from a side of the key blade opposite the multi-level ridge, and wherein the multi-level ridge comprises:

a first level extending from a front end of the keyway and configured to provide clearance for the shuttle pin located in the retracted position to enter the keyway within the key blade;

a second level located further from the front end of the keyway than the first level, projecting further from the side of the keyway than the first level, and configured to be contacted by the shuttle pin to position the shuttle pin in the extended position with the end of the shuttle pin extending into a relief formed in a side of the keyway opposite the second level;

a third level located further from the front end of the keyway than the second level, projecting further from the side of the keyway than the second level, and configured to engage a groove of the key blade;

a first transition ramp contiguous with the first level and the second level and configured to move the shuttle pin from the retracted position to the extended position; and

a second transition ramp contiguous with the second level and the third level and configured to block the shuttle pin from progressing past the second level; and

at least one supplemental sidebar control element disposed adjacent the keyway opposite the first transition ramp and configured to be contacted by a shuttle pin of the key blade moved to the extended position by the first transition ramp to actuate movement of the supplemental

sidebar control element for controlling radial movement of the sidebar within the sidebar opening, wherein the supplemental sidebar control element includes a shuttle pin engaging portion disposed within the relief formed in the keyway and laterally offset from the transversely extending projection of each secondary pin so that the supplemental sidebar control element is contacted by the shuttle pin in the extended position extending from the key into the relief but is not contacted by the secondary bittings of the key.

8. The lock assembly of claim 7, wherein each primary pin assembly comprises a primary pin and a primary pin driver arranged coaxially within holes formed in the housing and the plug that are aligned when the lock assembly is in a locked configuration, and wherein the primary pin assemblies control rotation of the plug within the housing by being elevated by the primary bittings of the key blade to positions within the aligned holes at which a separation between each primary pin and its associated primary pin driver is aligned with a shear line between the plug and the housing, and wherein the primary pin of each primary pin assembly that controls radial movement of the sidebar within the sidebar opening includes a sidebar recess formed in a side surface of the primary pin; and

wherein the sidebar includes a primary blocking lug extending therefrom associated with each primary pin assembly that controls radial movement of the sidebar within the sidebar opening and wherein each primary pin assembly that controls radial movement of the sidebar within the sidebar opening is rotatable within the aligned holes between a locked rotational orientation in which the sidebar recess is not aligned with the primary blocking lug and the primary blocking lug contacts the primary pin to prevent radial movement of the sidebar within the sidebar opening and an unlocked rotational orientation in which the sidebar recess is aligned with the primary blocking lug and the primary blocking lug can enter the sidebar recess to permit radial movement of the sidebar within the sidebar opening.

9. The lock assembly of claim 8, wherein the primary pin assemblies are elevated within the aligned holes by the primary bittings cut along a primary top edge of the key blade inserted into the keyway and the primary pin of each primary pin assembly that controls radial movement of the sidebar within the sidebar opening is rotated within the aligned holes by skewed cut bittings that engage angled chisel tips of the primary pin.

10. The lock assembly of any one of claims 7 to 9, wherein each secondary pin is disposed within an associated secondary hole formed in the plug and extending into the side bar opening, and each secondary pin includes a sidebar slot formed therein and the sidebar includes a secondary blocking shelf, and wherein each secondary pin is movable between a (i) locked position in which the sidebar slot is not aligned with the secondary blocking shelf and the secondary blocking shelf contacts the secondary pin to prevent radial movement of the sidebar within the sidebar opening and (ii) an unlocked position in which the sidebar slot is aligned with the secondary blocking shelf and the secondary blocking shelf can enter the sidebar slot to permit radial movement of the sidebar within the sidebar opening.

11. The lock assembly of claim 10, wherein each secondary pin is configured to be elevated within its associated secondary hole by the secondary bittings cut along a secondary top edge of a rib formed on the key blade inserted into the keyway.

12. The lock assembly of any one of claims 7 to 11, wherein the supplemental sidebar control element comprises at least one supplemental pin, wherein each supplemental pin is disposed within an associated supplemental pin hole formed in the plug and extends into the sidebar opening, and each supplemental pin includes a sidebar engagement feature formed therein and the sidebar includes a supplemental blocking feature associated with each supplemental pin, and wherein the shuttle pin contacts the shuttle pin engaging portion of each supplemental pin as the key is inserted into the keyway to move the supplemental pin between a (i) locked state in which the sidebar engagement feature is not aligned with the supplemental blocking feature and the supplemental blocking feature contacts the supplemental pin to prevent radial movement of the sidebar within the sidebar opening and (ii) an unlocked state in which the sidebar engagement feature is aligned with the supplemental blocking feature and the supplemental blocking feature can cooperate with the sidebar engagement feature to permit radial movement of the sidebar within the sidebar opening.

13. The lock assembly of claim 12, wherein

the supplemental pin comprises a lift pin,

the associated supplemental pin hole comprises a lift pin hole within which the lift pin is disposed for axial movement,

the sidebar engagement feature comprises a sidebar slot formed in the lift pin, and

the supplemental blocking feature comprises a supplemental blocking shelf formed on the sidebar, and wherein,

when the supplemental pin is in the locked state, the lift pin is axially positioned within the lift pin hole so that the sidebar slot of the lift pin is not aligned with the supplemental blocking shelf, and the supplemental blocking shelf contacts the lift pin to prevent radial movement of the sidebar within the sidebar opening, and

when the supplemental pin is in the unlocked state, the lift pin is axially positioned within the lift pin hole so that the sidebar slot of the lift pin is aligned with the supplemental blocking shelf, and the supplemental blocking shelf can enter the sidebar slot of the lift pin to permit radial movement of the sidebar within the sidebar opening.

14. The lock assembly of claim 12, wherein

the supplemental pin comprises a flipper pin,

the associated supplemental pin hole comprises a flipper pin hole within which the flipper pin is disposed for rotational movement about a longitudinal axis of the flipper pin,

the sidebar engagement feature comprises a sidebar engaging lug formed on the flipper pin, and

the supplemental blocking feature comprises a flipper pin cutout formed in the sidebar, and wherein,

when the supplemental pin is in the locked state, the flipper pin is rotationally oriented within the flipper pin hole so that the sidebar engaging lug is not aligned with the flipper pin cutout, and the sidebar engaging lug contacts the sidebar to prevent radial movement of the sidebar within the sidebar opening, and

when the supplemental pin is in the unlocked state, the flipper pin is rotationally oriented within the flipper pin hole so that the sidebar engaging lug is aligned with the flipper pin cutout, and the sidebar engaging lug can enter the flipper pin cutout to permit radial movement of the sidebar within the sidebar opening.

15. The lock assembly of any one of claims 7 to 11, wherein

the supplemental sidebar control element comprises at least one slider disposed within an associated slider hole formed in the plug for axial movement with respect to the plug,

wherein the slider hole extends into the sidebar opening, and wherein the slider includes a sidebar blocking lug projecting therefrom and the sidebar includes a slider cutout, and

wherein the shuttle pin contacts the shuttle pin engaging portion of the slider as the key is inserted into the keyway to move the slider between a (i) locked state in which the sidebar blocking lug is not aligned with the slider cutout and the sidebar contacts the sidebar blocking lug to prevent radial movement of the sidebar within the sidebar opening and (ii) an unlocked state in which the sidebar blocking lug is aligned with the slider cutout and the slider cutout receives the sidebar blocking lug to permit radial movement of the sidebar within the sidebar opening.

16. The lock assembly of any one of claims 7 to 11, wherein one of the supplemental sidebar control element and the sidebar includes a supplemental sidebar control recess that receives an associated supplemental blocking feature and the other of the supplemental sidebar control element and the sidebar includes a supplemental blocking feature configured to be received within a supplemental sidebar control recess that is aligned with the associated supplemental blocking feature, and each supplemental sidebar control element is movably controlled by the shuttle pin of the key inserted into the keyway for movement between (i) a locked state in which the supplemental sidebar control recess is not aligned with the associated supplemental blocking feature and the supplemental blocking feature contacts the supplemental sidebar control element to prevent radial movement of the sidebar within the sidebar opening and (ii) an unlocked state in which the supplemental sidebar control recess is aligned with the associated supplemental blocking feature and the supplemental blocking feature can enter the supplemental sidebar control recess to permit radial movement of the sidebar within the sidebar opening.

17. The lock assembly of claim 16, wherein

the supplemental sidebar control element comprises a lift pin within a lift pin hole within which the lift pin is disposed for axial movement,

the supplemental sidebar control recess comprises a sidebar slot formed in the lift pin, and

the supplemental blocking feature comprises a supplemental blocking shelf formed on the sidebar, and wherein,

when the supplemental sidebar control element is in the locked state, the lift pin is axially positioned within the lift pin hole so that the sidebar slot of the lift pin is not aligned with the supplemental blocking shelf, and the supplemental blocking shelf contacts the lift pin to prevent radial movement of the sidebar within the sidebar opening, and

when the supplemental sidebar control element is in the unlocked state, the lift pin is axially positioned within the lift pin hole so that the sidebar slot of the lift pin is aligned with the supplemental blocking shelf, and the supplemental blocking shelf can enter the sidebar slot of the lift pin to permit radial movement of the sidebar within the sidebar opening.

18. The lock assembly of claim 17, wherein the lift pin comprises a beveled edge configured to be engaged by the shuttle pin of the key blade inserted into the keyway to axially move the lift pin within the lift pin hole from the locked state to the unlocked state.

19. The lock assembly of claim 16, wherein

the supplemental sidebar control element comprises a flipper pin within a flipper pin hole within which the flipper pin is disposed for rotational movement about a longitudinal axis of the flipper pin,

the supplemental blocking feature comprises a sidebar engaging lug formed on the flipper pin, and

the supplemental sidebar control recess comprises a flipper pin cutout formed in the sidebar, and wherein,

when the supplemental sidebar control element is in the locked state, the flipper pin is rotationally oriented within the flipper pin hole so that the sidebar engaging lug is not aligned with the flipper pin cutout, and the sidebar engaging lug contacts the sidebar to prevent radial movement of the sidebar within the sidebar opening, and

when the supplemental sidebar control element is in the unlocked state, the flipper pin is rotationally oriented within the flipper pin hole so that the sidebar engaging lug is aligned with the flipper pin cutout, and the sidebar engaging lug can enter the flipper pin cutout to permit radial movement of the sidebar within the sidebar opening.

20. The lock assembly of claim 19, wherein the flipper pin comprises a transversely extending shuttle pin engaging portion configured to be engaged by the shuttle pin of the key

blade inserted into the keyway to rotate the flipper pin from the locked state to the unlocked state.

21. The lock assembly of claim 16, wherein

the supplemental sidebar control element comprises at least one slider disposed within an associated slider hole formed in the plug for axial movement with respect to the plug,

the supplemental blocking feature comprises a sidebar blocking lug projecting from the slider, and

the supplemental sidebar control recess comprises a slider cutout formed in the sidebar, and wherein

when the supplemental sidebar control element is in the locked state, the sidebar blocking lug is not aligned with the slider cutout and the sidebar contacts the sidebar blocking lug to prevent radial movement of the sidebar within the sidebar opening and

when the supplemental sidebar control element is in the unlocked state, the sidebar blocking lug is aligned with the slider cutout and the slider cutout receives the sidebar blocking lug to permit radial movement of the sidebar within the sidebar opening.

22. The lock assembly of claim 21, wherein the slider comprises a projection configured to be engaged by the shuttle pin of the key blade inserted into the keyway to axially move the slider within the slider hole from the locked state to the unlocked state.

23. A plug assembly for a lock assembly, the plug assembly comprising:

a plug configured to be rotatably disposed within a bore of a housing;

a keyway formed in the plug and shaped to receive a correspondingly-shaped key blade of a key and having a width extending laterally from a first side of the keyway to an opposing second side of the keyway;

a sidebar disposed within a sidebar opening formed in the plug and configured for radial movement with respect to an axis of rotation of the plug for engaging a sidebar groove formed in a wall of the bore formed in the housing for controlling rotation of the plug within the housing;

primary pin assemblies aligned with the keyway and configured to be contacted by primary bittings of the key blade for controlling rotation of the plug within the bore and radial movement of the sidebar within the sidebar opening;

one or more secondary pins disposed adjacent the keyway and configured to be contacted by secondary bittings of the key blade for controlling radial movement of the sidebar within the sidebar opening, wherein each secondary pin comprises a transversely extending projection extending into the keyway to be contacted by a secondary bitting of the key blade;

at least one sidebar control element disposed adjacent the keyway and configured to be contacted by a shuttle pin of the key for controlling movement of the sidebar control element between a locked state blocking radial movement of the sidebar within the sidebar opening and an unlocked state permitting radial movement of the sidebar within the sidebar opening, wherein the sidebar control element includes a shuttle pin engaging portion that is laterally offset from the transversely extending projection of each secondary pin so that the sidebar control element is contacted by the shuttle pin extending from the key but is not contacted by the secondary bittings of the key,

a multi-level ridge projecting from the second side of the keyway and extending longitudinally along at least a portion of the length of the second side of the keyway, wherein the multi-level ridge is configured to engage at least one shuttle pin disposed within the key blade inserted into the keyway, wherein the shuttle pin is configured for movement within the key blade between a retracted position in which one end of the shuttle pin is retracted with respect to a side of the key blade opposite the multi-level ridge, to an extended position, in which the end of the shuttle pin is extended from side of the key blade opposite the multi-level ridge to actuate movement of the sidebar control element from the locked state to the unlocked state, and wherein the multi-level ridge comprises:

a first level extending from a front end of the keyway and configured to provide clearance for the shuttle pin in the retracted position within the key blade to enter the keyway;

a second level located further from the front end of the keyway than the first level, projecting further from the second side of the keyway than the first level, located opposite to the sidebar control element, and configured to be contacted by the shuttle pin to position the shuttle pin in the extended position with the end of the shuttle pin extending into a relief formed in the first side of the keyway opposite the second level;

a third level located further from the front end of the keyway than the second level, projecting further from the second side of the keyway than the second level, and configured to engage a groove of the key blade;

a first transition ramp contiguous with the first level and the second level and configured to move the shuttle pin from the retracted position to the extended position; and

a second transition ramp contiguous with the second level and the third level and configured to block the shuttle pin from progressing past the second level.

24. The plug assembly of claim 23, wherein

the sidebar control element comprises a lift pin disposed within a lift pin hole for axial movement and having a sidebar slot extending transversely across the lift pin, and

the sidebar comprises a blocking shelf, wherein

when the sidebar control element is in the locked state, the lift pin is axially positioned within the lift pin hole so that the sidebar slot is not aligned with the blocking shelf, and the blocking shelf contacts the lift pin to prevent radial movement of the sidebar within the sidebar opening, and

when the sidebar control element is in the unlocked state, the lift pin is axially positioned within the lift pin hole so that the sidebar slot is aligned with the blocking shelf, and the blocking shelf can enter the sidebar slot to permit radial movement of the sidebar within the sidebar opening.

25. The plug assembly of claim 23, wherein

the sidebar control element comprises at least one slider disposed within an associated slider hole formed in the plug for axial movement with respect to the plug, and having a sidebar blocking lug projecting from the slider, and

the sidebar comprises a slider cutout, wherein

when the sidebar control element is in the locked state, the sidebar blocking lug is not aligned with the slider cutout and the sidebar contacts the sidebar blocking lug to prevent radial movement of the sidebar within the sidebar opening, and

when the sidebar control element is in the unlocked state, the sidebar blocking lug is aligned with the slider cutout and the slider cutout receives the sidebar blocking lug to permit radial movement of the sidebar within the sidebar opening.

26. The plug assembly of claim 23, wherein

the sidebar control element comprises a flipper pin disposed within a flipper pin hole within which the flipper pin for rotational movement about a longitudinal axis of the flipper pin, and having a sidebar engaging lug, and

the sidebar comprises a flipper pin cutout, wherein

when the sidebar control element is in the locked state, the flipper pin is rotationally oriented within the flipper pin hole so that the sidebar engaging lug is not aligned with the flipper pin cutout, and the sidebar engaging lug contacts the sidebar to prevent radial movement of the sidebar within the sidebar opening, and

when the sidebar control element is in the unlocked state, the flipper pin is rotationally oriented within the flipper pin hole so that the sidebar engaging lug is aligned with the flipper pin cutout, and the sidebar engaging lug can enter the flipper pin cutout to permit radial movement of the sidebar within the sidebar opening.

27. The plug assembly of any one of claims 23 to 26, wherein the third level extends beyond a center line bisecting the width of the keyway between the first side of the keyway and the second side of the keyway.

28. A lock assembly comprising

a housing;

a plug rotatably disposed within a bore formed in the housing;

a keyway formed within the plug, shaped to receive a correspondingly-shaped key blade, and having a length extending longitudinally through the plug and a width extending laterally from a first side of the keyway to an opposing second side of the keyway;

a sidebar disposed within a sidebar opening formed in the plug and configured for radial movement with respect to an axis of rotation of the plug for engaging a sidebar groove formed in a wall of the bore formed in the housing for controlling rotation of the plug within the housing; and

a first sidebar control element and a second sidebar control element disposed within the plug on the first side of the keyway, wherein the first and second sidebar control elements are configured for movement between a locked state blocking radial movement of the sidebar within the sidebar opening and an unlocked state permitting radial movement of the sidebar within the sidebar opening,

a multi-level ridge projecting from the second side of the keyway and extending longitudinally along at least a portion of the length of the second side of the keyway, wherein the multi-level ridge is configured to engage a first shuttle pin and a second shuttle pin disposed within the key blade inserted into the keyway, wherein

the first shuttle pin is configured for movement within the key blade between a first position, in which a second end of the first shuttle pin extends into a groove formed in a side of the key blade, to a second position, in which the second end of the first shuttle pin is moved out of the groove and a first end of the first shuttle pin extends from the first side of the key blade to actuate movement of the first sidebar control element from the locked state to the unlocked state, and

the second shuttle pin is configured for movement within the key blade between a first position, in which a second end of the second shuttle pin extends into the groove, to a second position, in which the second end of the second shuttle pin is moved out of the groove and a first end of the second shuttle pin extends from the first side of the key blade to actuate movement of the second sidebar control element from the locked state to the unlocked state, and wherein the multi-level ridge comprises:

a first section comprising:

a first section first level extending from a front end of the keyway and configured to provide clearance for the first shuttle pin in the first position within the key blade and the second shuttle pin in the first position within the key blade to enter the keyway;

a first section second level located further from the front end of the keyway than the first section first level, wherein the first section second level projects further from the second side of the keyway than the first section first level, is located opposite to the first sidebar control element, and is configured to be contacted by the first shuttle pin to position the first shuttle pin in the second position with the first end of the first shuttle pin extending into a first relief formed in the first side of the keyway opposite the first section second level;

a first section first transition ramp contiguous with the first section first level and the first section second level and configured to move the first shuttle pin and second shuttle pin from the first position to the second position as the key blade is inserted into the keyway; and

a regression ramp contiguous with the first section second level and configured to move the second shuttle pin from the second position to the first position as the key blade is inserted into the keyway; and

a second section located further from the front end of the keyway than the first section, and comprising:

a second section first level configured to provide clearance for the second shuttle pin located in the first position within the key blade to enter the second section;

a second section second level located further from the front end of the keyway than the second section first level, wherein the second section second level projects further from the second side of the keyway than the second section first level, is located opposite to the second sidebar control element, and is configured to be contacted by the second shuttle pin to position the second shuttle pin in the second position with the first end of the second shuttle pin extending into a second relief formed in the first side of the keyway opposite the second section second level;

a third level located further from the front end of the keyway than the second section second level, projecting further from the second side of the keyway than the second section second level, and configured to engage the groove of the key blade;

a second section first transition ramp contiguous with the second section first level and the second section second level and configured to move the second shuttle pin from the first position to the second position as the key blade is inserted into the keyway; and

a second transition ramp contiguous with the second section second level and the third level and configured to block the second shuttle pin from progressing past the second section second level and to prevent the key blade from further insertion.

29. The lock assembly of claim 28, wherein

at least one of the first sidebar control element and the second sidebar control element comprises a lift pin disposed within a lift pin hole for axial movement and having a sidebar slot extending transversely across the lift pin, and

the sidebar comprises a blocking shelf, wherein

when the at least one of the first sidebar control element and the second sidebar control element is in the locked state, the lift pin is axially positioned within the lift pin hole so that the

sidebar slot is not aligned with the blocking shelf, and the blocking shelf contacts the lift pin to prevent radial movement of the sidebar within the sidebar opening, and

when the at least one of the first sidebar control element and the second sidebar control element is in the unlocked state, the lift pin is axially positioned within the lift pin hole so that the sidebar slot is aligned with the blocking shelf, and the blocking shelf can enter the sidebar slot to permit radial movement of the sidebar within the sidebar opening.

30. The lock assembly of claim 28, wherein

at least one of the first sidebar control element and the second sidebar control element comprises at least one slider disposed within an associated slider hole formed in the plug for axial movement with respect to the plug, and having a sidebar blocking lug projecting from the slider, and

the sidebar comprises a slider cutout, wherein

when the at least one of the first sidebar control element and the second sidebar control element is in the locked state, the sidebar blocking lug is not aligned with the slider cutout and the sidebar contacts the sidebar blocking lug to prevent radial movement of the sidebar within the sidebar opening, and

when the at least one of the first sidebar control element and the second sidebar control element is in the unlocked state, the sidebar blocking lug is aligned with the slider cutout and the slider cutout receives the sidebar blocking lug to permit radial movement of the sidebar within the sidebar opening.

31. The lock assembly of claim 28, wherein

at least one of the first sidebar control element and the second sidebar control element comprises a flipper pin disposed within a flipper pin hole within which the flipper pin for rotational movement about a longitudinal axis of the flipper pin, and having a sidebar engaging lug, and

the sidebar comprises a flipper pin cutout, wherein

when the at least one of the first sidebar control element and the second sidebar control element is in the locked state, the flipper pin is rotationally oriented within the flipper pin hole so that the sidebar engaging lug is not aligned with the flipper pin cutout, and the sidebar engaging

lug contacts the sidebar to prevent radial movement of the sidebar within the sidebar opening, and

when the at least one of the first sidebar control element and the second sidebar control element is in the unlocked state, the flipper pin is rotationally oriented within the flipper pin hole so that the sidebar engaging lug is aligned with the flipper pin cutout, and the sidebar engaging lug can enter the flipper pin cutout to permit radial movement of the sidebar within the sidebar opening.