

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 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, wherein the key blank further comprises a shuttle pin retainer disposed with in a retainer hole and intersects the through hole between the first head portion and the second head portion of the shuttle pin.
3. The key blank of claim 1 or 2, wherein the shuttle pin extends through the rib.
4. 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, wherein the key comprises a key blade configured to be inserted into the keyway of the lock, the key blade comprising:
 - a primary top edge having primary bittings cut therein for controlling the primary pins pin assemblies of the lock when the key 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 has secondary bittings cut therein for controlling the secondary pins of the lock when the key is inserted into the keyway;
 - 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 second 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.

5. The key of claim 4, wherein the primary bittings are skew type bittings configured to elevate and rotate the primary pin assemblies.

6. The key of claim 4 or 5, 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.

7. The key of claim 6, further comprising a shuttle pin retainer, wherein the shuttle pin retainer is disposed in a retainer hole and intersects the through hole between the first head portion and the second head portion of the shuttle pin.

8. 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 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 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 biting of the key; and

at least one supplemental sidebar control element disposed adjacent the keyway and configured to be contacted by a shuttle pin of the key for controlling radial movement of the sidebar within the sidebar opening and including a shuttle pin engaging portion that is laterally offset from the transversely extending portion of each secondary pin so that the supplemental sidebar control element is contacted by the shuttle pin extending from the key but is not contacted by the secondary bittings of the key.

9. The lock assembly of claim 8, 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 to a position 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 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.

10. The lock assembly of claim 8 or 9, wherein the primary pin assemblies are elevated within the aligned holes by primary bittings cut along a primary top edge of a blade of a key

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.

11. The lock assembly of any one of claims 8 to 10, 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.

12. The lock assembly of any one of claims 8 to 11, wherein each secondary pin is configured to be elevated within its associated secondary hole by secondary bittings cut along a secondary top edge of a rib formed on a blade of a key inserted into the keyway.

13. The lock assembly of any one of claims 8 to 12, 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 each supplemental pin is movable 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.

14. The lock assembly of claim 13, wherein the supplemental pin is moved between the locked state and the unlocked state by the shuttle pin movably disposed within a key blade and

moveable as the key is inserted into the keyway between a first position retracted into the key blade and a second position extended from the key blade to engage the supplemental pin and move the supplemental pin from the locked state to the unlocked state.

15. The lock assembly as in claim 13 or 14, 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 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 is aligned with the supplemental blocking shelf, and the supplemental blocking shelf can enter the sidebar slot to permit radial movement of the sidebar within the sidebar opening.

16. The lock assembly as in claim 13 or 14, 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.

17. The lock assembly of any one of claims 8 to 14, 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 slider is movable 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.

18. The lock assembly of any one of claims 8 to 14, 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 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.

19. The lock assembly of claim 18, 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 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 is aligned with the supplemental blocking shelf, and the supplemental blocking shelf can enter the sidebar slot to permit radial movement of the sidebar within the sidebar opening.

20. The lock assembly of claim 19, 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.

21. The lock assembly of claim 18, 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 sidebar engagement 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.

22. The lock assembly of claim 21, 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.

23. The lock assembly of claim 18, 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 sidebar engagement 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.

24. The lock assembly of claim 23, 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 slider within the slider hole from the locked state to the unlocked state.

25. A lock assembly comprising
a cylindrical 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

at least one sidebar control element disposed within the plug on the second side of the keyway and 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 first side of the keyway and extending longitudinally along at least a portion of the length of the first side of the keyway, wherein the multi-level ridge is configured to engage at least one shuttle pin disposed within a key blade inserted into the keyway, wherein the shuttle pin is configured for movement within the key blade between a first position, in which a second end of the shuttle pin extends into the groove, to a second position, in which the second end of the shuttle pin is moved out of the groove and a first end of the shuttle pin extends from the first side of the key blade to actuate movement of the sidebar control element from the first state to the second 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 located in the first 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 first 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 second position with the first end of the shuttle pin extending into a relief formed in the second 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 first 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 first position to the second 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.

26. The lock assembly of claim 25, wherein

the supplemental 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.

27. The lock assembly of claim 25 or 26, 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.

28. The lock assembly of claims 25 to 27 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.

29. The lock assembly of any one of claims 25 to 28, 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.

30. A plug for a lock assembly, the plug comprising

a keyway shaped to receive a correspondingly-shaped key blade 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; and

at least one sidebar control element disposed adjacent the keyway and configured to be contacted by a shuttle pin of the key for controlling radial movement of the sidebar within the sidebar opening and including a shuttle pin engaging portion that is laterally offset from the transversely extending portion 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 first side of the keyway and extending longitudinally along at least a portion of the length of the first side of the keyway, wherein the

multi-level ridge is configured to engage at least one shuttle pin disposed within a 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 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 first 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 second 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 first 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.

31. The plug of claim 30, wherein

- the supplemental 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.

32. The plug of claim 30, 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.

33. The plug of claim 30, 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.

34. The plug of claim 30, 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.

35. A key blank to be formed into a key for operating a lock having a cylindrical housing; a plug rotatably disposed within a bore formed in the housing; a keyway formed within the plug having a multi-level ridge with a first level, first transition ramp, second level, second transition ramp, and third level; 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 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;

- a bottom edge;

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

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

- at least one shuttle pin disposed within a through-hole extending through the key blade from the first side to the second side,

- wherein the shuttle pin is configured to engage a multi-level ridge projecting from a second 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 shuttle pin from a first position, in which a second end of the shuttle pin extends into the groove, to a second position, in which the second end of the shuttle pin is moved out of the groove and a first end of the shuttle pin extends from the first side of the key blade to actuate the supplemental sidebar control element.

36. The key blank of claim 35, 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.

37. The key of claim 35, further comprising a shuttle pin retainer, wherein the shuttle pin retainer is disposed in a retainer hole and intersects the through hole between the first head portion and the second head portion of the shuttle pin.
38. The key blank of claim 35, wherein
the supplemental 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 shuttle pin is in the first position, the lift pin is axially positioned within the lift pin hole so that the sidebar slot 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 shuttle pin is in the second position, the lift pin is axially positioned within the lift pin hole so that the sidebar slot is aligned with the supplemental blocking shelf, and the supplemental blocking shelf can enter the sidebar slot to permit radial movement of the sidebar within the sidebar opening.
39. The key blank of claim 35, wherein
the supplemental sidebar control element comprises at least one flipper pin disposed within a flipper pin hole for rotational movement about a longitudinal axis of the flipper pin, and having a sidebar engaging lug formed on the flipper pin, and
the sidebar comprises a flipper pin cutout, and wherein,
when the shuttle pin is in the first position, 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 shuttle pin is in the second position, 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.
40. The key blank of claim 35, 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, and having a sidebar blocking lug projecting from the slider, and

the sidebar comprises a slider cutout, wherein

when the shuttle pin is in the first position, 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 shuttle pin is in the second position, 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.

41. The key blank of claim 35 having two or more shuttle pins.

42. The key blank of claim 35, wherein the groove is paracentric to a centerline of the key blade.

43. A key for operating a lock having a cylindrical housing; a plug rotatably disposed within a bore formed in the housing and having a front face and end face; a keyway formed within the plug having a multi-level ridge with a first level, first transition ramp, second level, second transition ramp, and third level; a sidebar disposed within a sidebar opening formed in the plug and configured for lateral 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 at least one supplemental sidebar control element for controlling radial movement of the sidebar within the sidebar opening, wherein the key comprises a key blade configured to be inserted into a keyway of the lock, the key blade comprising:

a primary top edge having primary bittings cut therein for controlling the primary pin assemblies of the lock when the key is inserted into the keyway;

a bottom edge;

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

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

at least one shuttle pin disposed within a through-hole extending through the key blade from the first side to the second side,

wherein the shuttle pin is configured to engage a multi-level ridge projecting from a second 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 shuttle pin from a first position, in which a second end of the shuttle pin extends into the groove, to a second position, in which the second end of the shuttle pin is moved out of the groove and a first end of the shuttle pin extends from the first side of the key blade to actuate the supplemental sidebar control element.

44. The key of claim 43, wherein

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

the sidebar comprises a supplemental blocking shelf, wherein

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

45. The key of claim 43, 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, and having a sidebar blocking lug projecting from the slider, and

the sidebar comprises a slider cutout, wherein

when the shuttle pin is in the first position, 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 shuttle pin is in the second position, 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.

46. The key of claim 43, wherein

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

the sidebar comprises a flipper pin cutout, and wherein,

when the shuttle pin is in the first position, 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 shuttle pin is in the second position, 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.

47. The key of claim 43, wherein the groove is paracentric to a centerline of the key blade.

48. A lock assembly comprising

a cylindrical 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 second side of the keyway and 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 first side of the keyway and extending longitudinally along at least a portion of the length of the first side of the keyway, wherein the multi-level ridge is configured to engage a first shuttle pin and a second shuttle pin disposed within a 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 the groove, 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 and second shuttle pin located in the first position to enter the keyway within the key blade;

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 first 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 second 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 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; 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 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 first 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 second 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 first side of the keyway than the second section second level, and configured to engage a 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; 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 from further insertion.

49. The lock assembly of claim 48, 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 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.

50. The lock assembly of claim 48, 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 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.

51. The lock assembly of claim 48, 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 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.