CLAIMS

The invention claimed is:

1. A milling system for forming a casing exit, comprising:

a mill arranged within a shroud and configured to translate axially with respect to the shroud once detached ~~therefrom~~ from the shroud;

a guide block coupled to a distal end of the mill and configured to guide and support the mill while the mill forms the casing exit; ~~and~~

a guide support arranged within the shroud and having a ramp portion that transitions into a planar portion, the guide support defining one or more longitudinal channels configured to accumulate cuttings and debris such that the cuttings and debris remain out of a path of the mill as ~~it~~ the mill moves axially along the guide support~~.~~; and

one or more magnets arranged within the one or more longitudinal channels, the one or more magnets being configured to magnetically attract the cuttings and debris.

2. The milling system of claim 1, wherein the guide support forms an integral part of the shroud.

3. The milling system of claim 1, wherein the one or more longitudinal channels are defined on the planar portion of the guide support.

4. The milling system of claim 1, wherein the one or more longitudinal channels are defined on both the ramp portion and the planar portion of the guide support.

5. The milling system of claim 1, further comprising one or more pockets arranged longitudinally within the longitudinal channels and defining an entrance at a downhole end to capture cuttings and debris.

6. The milling system of claim 5, wherein the one or more pockets are mesh-like structures.

~~7. The milling system of claim 1, further comprising one or more magnets arranged within the one or more longitudinal channels, the one or more magnets being configured to magnetically attract the cuttings and debris.~~

~~8~~7. A milling system for forming a casing exit, comprising :

a shroud defining a plurality of perforations arranged as a first axial perforation set and a second axial perforation set, the first axial perforation set being axially offset uphole from the second axial perforation set;

a mill arranged within the shroud and coupled to a stem that extends longitudinally ~~therefrom~~ from the mill;

one or more pistons arranged about the stem and configured to be actuated radially with respect to the stem in order to engage or disengage the plurality of perforations of either of the first axial perforation set or the second axial perforation set; and

a sleeve arranged within the shroud and defining one or more piston guides configured to receive and rotationally align the one or more pistons with the plurality of perforations of either of the first or the second axial perforation sets.

~~9~~8. The milling system of claim ~~8~~7, wherein the one or more piston guides define corresponding elongate alignment slots that provide axial space for the pistons to axially translate and locate and engage either the first axial perforation set or the second axial perforation set.

~~10~~9. The milling system of claim ~~8~~7, wherein rotationally aligning the pistons with the plurality of perforations also rotationally locks the stem and the mill, both rotationally and axially, with respect to the shroud such that the milling system can be properly retrieved to a well surface.

~~11~~10. The milling system of claim ~~10~~9, wherein the milling system is axially and rotationally aligned with the well surface.

~~12~~11. A method for managing cuttings and debris while forming a casing exit, comprising :

introducing a milling system downhole, the milling system having a mill arranged within a shroud and a guide block coupled to a distal end of the mill and a stem coupled to an opposing end of the mill and extending longitudinally ~~therefrom~~ from the mill;

disengaging the stem and the mill from the shroud by radially actuating one or more pistons arranged about the stem;

guiding the mill downhole with respect to the shroud with a guide support arranged at least partially within the shroud, the guide support having a ramp portion that transitions into a planar portion;

urging the mill into contact with a casing string with the ramp portion and thereby initiating the formation of the casing exit;

advancing the mill downhole to continue milling the casing exit; and

accumulating at least a portion of the cuttings and debris resulting from the milling of the casing exit within one or more longitudinal channels defined in the guide support~~.~~

wherein the method further comprising the step of capturing cuttings and debris within one or more pockets arranged longitudinally within the longitudinal channels, each pocket defining an entrance at a downhole end thereof.

~~13~~12. The method of claim ~~12~~11, wherein the one or more longitudinal channels are defined on the planar portion of the guide support.

~~14~~13. The method of claim ~~12~~11, wherein the one or more longitudinal channels are defined on both the ramp portion and the planar portion of the guide support.

~~15~~14. The method of claim ~~12~~11, wherein guiding the mill downhole further comprises supporting the mill with the guide block which engages the guide support.

~~16. The method of claim 12, further comprising capturing cuttings and debris within one or more pockets arranged longitudinally within the longitudinal channels, each pocket defining an entrance at a downhole end thereof.~~

~~17~~15. The method of claim ~~12~~11, further comprising magnetically-attracting the cuttings and debris into the one or more longitudinal channels with one or more magnets arranged therein.

~~18~~16. The method of claim ~~12~~11, wherein disengaging the stem and the mill from the shroud further comprises radially actuating one or more pistons arranged about the stem.

~~19~~17. The method of claim ~~18~~16, further comprising:

retracting the mill back toward the shroud, the shroud defining a plurality of perforations arranged as a first axial perforation set and a second axial perforation set, the first axial perforation set being axially offset uphole from the second axial perforation set;

engaging and receiving the one or more pistons with one or more piston guides defined on a sleeve arranged within the shroud; and rotationally aligning with the one or more piston guides the one or more pistons with the plurality of perforations of either of the first or the second axial perforation sets.

~~20~~18. The method of claim ~~19~~17, further comprising~~-~~:

advancing the one or more pistons within the one or more piston guides until axially aligning with either the first axial perforation set or the second axial perforation set; and

in the event the cuttings and debris prevent the one or more pistons from advancing to the first axial perforation set, radially actuating the one or more pistons at the second axial perforation set in order to re-engage the stem and the mill to the shroud.

~~21~~19. The method of claim ~~19~~17, wherein rotationally aligning the one or more pistons with the plurality of perforations further comprises rotationally and axially locking the stem and the mill with respect to the shroud such that the milling system can be properly retrieved to a well surface.

~~22~~20. The method of claim ~~12~~11, further comprising:

retracting the mill back toward the shroud, the shroud defining a plurality of engagement locations configured to rotationally and axially lock the mill to the shroud;

engaging and receiving a collet and key assembly defined on the stem with one or more piston guides defined on a sleeve arranged within the shroud;

rotationally aligning with the one or more piston guides the collet and key assembly with the plurality of engagement locations; and advancing the collet and key assembly within the one or more piston guides until axially and rotationally locking the collet and key assembly with at least one of the plurality of engagement locations.

CLAIMS

The invention claimed is:

1. A milling system for forming a casing exit, comprising:

a mill arranged within a shroud and configured to translate axially with respect to the shroud once detached therefrom;

a guide block coupled to a distal end of the mill and configured to guide and support the mill while the mill forms the casing exit; and

a guide support arranged within the shroud and having a ramp portion that transitions into a planar portion, the guide support defining one or more longitudinal channels configured to accumulate cuttings and debris such that the cuttings and debris remain out of a path of the mill as it moves axially along the guide support.

2. The milling system of claim 1, wherein the guide support forms an integral part of the shroud.

3. The milling system of claim 1, wherein the one or more longitudinal channels are defined on the planar portion of the guide support.

4. The milling system of claim 1, wherein the one or more longitudinal channels are defined on both the ramp portion and the planar portion of the guide support.

5. The milling system of claim 1, further comprising one or more pockets arranged longitudinally within the longitudinal channels and defining an entrance at a downhole end to capture cuttings and debris.

6. The milling system of claim 5, wherein the one or more pockets are mesh-like structures.

7. The milling system of claim 1, further comprising one or more magnets arranged within the one or more longitudinal channels, the one or more magnets being configured to magnetically attract the cuttings and debris.

8. A milling system for forming a casing exit, comprising:

a shroud defining a plurality of perforations arranged as a first axial perforation set and a second axial perforation set, the first axial perforation set being axially offset uphole from the second axial perforation set;

a mill arranged within the shroud and coupled to a stem that extends longitudinally therefrom;

one or more pistons arranged about the stem and configured to be actuated radially with respect to the stem in order to engage or disengage the plurality of perforations of either of the first axial perforation set or the second axial perforation set; and

a sleeve arranged within the shroud and defining one or more piston guides configured to receive and rotationally align the one or more pistons with the plurality of perforations of either of the first or the second axial perforation sets.

9. The milling system of claim 8, wherein the one or more piston guides define corresponding elongate alignment slots that provide axial space for the pistons to axially translate and locate and engage either the first axial perforation set or the second axial perforation set.

10. The milling system of claim 8, wherein rotationally aligning the pistons with the plurality of perforations also rotationally locks the stem and the mill, both rotationally and axially, with respect to the shroud such that the milling system can be properly retrieved to a well surface.

11. The milling system of claim 10, wherein the milling system is axially and rotationally aligned with the well surface.

12. A method for managing cuttings and debris while forming a casing exit, comprising:

introducing a milling system downhole, the milling system having a mill arranged within a shroud and a guide block coupled to a distal end of the mill and a stem coupled to an opposing end of the mill and extending longitudinally therefrom;

disengaging the stem and the mill from the shroud;

guiding the mill downhole with respect to the shroud with a guide support arranged at least partially within the shroud, the guide support having a ramp portion that transitions into a planar portion;

urging the mill into contact with a casing string with the ramp portion and thereby initiating the formation of the casing exit;

advancing the mill downhole to continue milling the casing exit; and

accumulating at least a portion of the cuttings and debris resulting from the milling of the casing exit within one or more longitudinal channels defined in the guide support.

13. The method of claim 12, wherein the one or more longitudinal channels are defined on the planar portion of the guide support.

14. The method of claim 12, wherein the one or more longitudinal channels are defined on both the ramp portion and the planar portion of the guide support.

15. The method of claim 12, wherein guiding the mill downhole further comprises supporting the mill with the guide block which engages the guide support.

16. The method of claim 12, further comprising capturing cuttings and debris within one or more pockets arranged longitudinally within the longitudinal channels, each pocket defining an entrance at a downhole end thereof.

17. The method of claim 12, further comprising magnetically-attracting the cuttings and debris into the one or more longitudinal channels with one or more magnets arranged therein.

18. The method of claim 12, wherein disengaging the stem and the mill from the shroud further comprises radially actuating one or more pistons arranged about the stem.

19. The method of claim 18, further comprising:

retracting the mill back toward the shroud, the shroud defining a plurality of perforations arranged as a first axial perforation set and a second axial perforation set, the first axial perforation set being axially offset uphole from the second axial perforation set;

engaging and receiving the one or more pistons with one or more piston guides defined on a sleeve arranged within the shroud; and

rotationally aligning with the one or more piston guides the one or more pistons with the plurality of perforations of either of the first or the second axial perforation sets.

20. The method of claim 19, further comprising:

advancing the one or more pistons within the one or more piston guides until axially aligning with either the first axial perforation set or the second axial perforation set; and

in the event the cuttings and debris prevent the one or more pistons from advancing to the first axial perforation set, radially actuating the one or more pistons at the second axial perforation set in order to re-engage the stem and the mill to the shroud.

21. The method of claim 19, wherein rotationally aligning the one or more pistons with the plurality of perforations further comprises rotationally and axially locking the stem and the mill with respect to the shroud such that the milling system can be properly retrieved to a well surface.

22. The method of claim 12, further comprising:

retracting the mill back toward the shroud, the shroud defining a plurality of engagement locations configured to rotationally and axially lock the mill to the shroud;

engaging and receiving a collet and key assembly defined on the stem with one or more piston guides defined on a sleeve arranged within the shroud;

rotationally aligning with the one or more piston guides the collet and key assembly with the plurality of engagement locations; and

advancing the collet and key assembly within the one or more piston guides until axially and rotationally locking the collet and key assembly with at least one of the plurality of engagement locations.

CLAIMS

The invention claimed is:

1. A milling system for forming a casing exit, comprising:

a mill arranged within a shroud and configured to translate axially with respect to the shroud once detached from the shroud;

a guide block coupled to a distal end of the mill and configured to guide and support the mill while the mill forms the casing exit;

a guide support arranged within the shroud and having a ramp portion that transitions into a planar portion, the guide support defining one or more longitudinal channels configured to accumulate cuttings and debris such that the cuttings and debris remain out of a path of the mill as the mill moves axially along the guide support; and

one or more magnets arranged within the one or more longitudinal channels, the one or more magnets being configured to magnetically attract the cuttings and debris.

2. The milling system of claim 1, wherein the guide support forms an integral part of the shroud.

3. The milling system of claim 1, wherein the one or more longitudinal channels are defined on the planar portion of the guide support.

4. The milling system of claim 1, wherein the one or more longitudinal channels are defined on both the ramp portion and the planar portion of the guide support.

5. The milling system of claim 1, further comprising one or more pockets arranged longitudinally within the longitudinal channels and defining an entrance at a downhole end to capture cuttings and debris.

6. The milling system of claim 5, wherein the one or more pockets are mesh-like structures.

7. A milling system for forming a casing exit, comprising:

a shroud defining a plurality of perforations arranged as a first axial perforation set and a second axial perforation set, the first axial perforation set being axially offset uphole from the second axial perforation set;

a mill arranged within the shroud and coupled to a stem that extends longitudinally from the mill;

one or more pistons arranged about the stem and configured to be actuated radially with respect to the stem in order to engage or disengage the plurality of perforations of either of the first axial perforation set or the second axial perforation set; and

a sleeve arranged within the shroud and defining one or more piston guides configured to receive and rotationally align the one or more pistons with the plurality of perforations of either of the first or the second axial perforation sets.

8. The milling system of claim 7, wherein the one or more piston guides define corresponding elongate alignment slots that provide axial space for the pistons to axially translate and locate and engage either the first axial perforation set or the second axial perforation set.

9. The milling system of claim 7, wherein rotationally aligning the pistons with the plurality of perforations also rotationally locks the stem and the mill, both rotationally and axially, with respect to the shroud such that the milling system can be properly retrieved to a well surface.

10. The milling system of claim 9, wherein the milling system is axially and rotationally aligned with the well surface.

11. A method for managing cuttings and debris while forming a casing exit, comprising :

introducing a milling system downhole, the milling system having a mill arranged within a shroud and a guide block coupled to a distal end of the mill and a stem coupled to an opposing end of the mill and extending longitudinally from the mill;

disengaging the stem and the mill from the shroud by radially actuating one or more pistons arranged about the stem;

guiding the mill downhole with respect to the shroud with a guide support arranged at least partially within the shroud, the guide support having a ramp portion that transitions into a planar portion;

urging the mill into contact with a casing string with the ramp portion and thereby initiating the formation of the casing exit;

advancing the mill downhole to continue milling the casing exit; and

accumulating at least a portion of the cuttings and debris resulting from the milling of the casing exit within one or more longitudinal channels defined in the guide support

wherein the method further comprising the step of capturing cuttings and debris within one or more pockets arranged longitudinally within the longitudinal channels, each pocket defining an entrance at a downhole end thereof.

12. The method of claim 11, wherein the one or more longitudinal channels are defined on the planar portion of the guide support.

13. The method of claim 11, wherein the one or more longitudinal channels are defined on both the ramp portion and the planar portion of the guide support.

14. The method of claim 11, wherein guiding the mill downhole further comprises supporting the mill with the guide block which engages the guide support.

15. The method of claim 11, further comprising magnetically-attracting the cuttings and debris into the one or more longitudinal channels with one or more magnets arranged therein.

16. The method of claim 11, wherein disengaging the stem and the mill from the shroud further comprises radially actuating one or more pistons arranged about the stem.

17. The method of claim 16, further comprising:

retracting the mill back toward the shroud, the shroud defining a plurality of perforations arranged as a first axial perforation set and a second axial perforation set, the first axial perforation set being axially offset uphole from the second axial perforation set;

engaging and receiving the one or more pistons with one or more piston guides defined on a sleeve arranged within the shroud; and rotationally aligning with the one or more piston guides the one or more pistons with the plurality of perforations of either of the first or the second axial perforation sets.

18. The method of claim 17, further comprising:

advancing the one or more pistons within the one or more piston guides until axially aligning with either the first axial perforation set or the second axial perforation set; and

in the event the cuttings and debris prevent the one or more pistons from advancing to the first axial perforation set, radially actuating the one or more pistons at the second axial perforation set in order to re-engage the stem and the mill to the shroud.

19. The method of claim 17, wherein rotationally aligning the one or more pistons with the plurality of perforations further comprises rotationally and axially locking the stem and the mill with respect to the shroud such that the milling system can be properly retrieved to a well surface.

20. The method of claim 11, further comprising:

retracting the mill back toward the shroud, the shroud defining a plurality of engagement locations configured to rotationally and axially lock the mill to the shroud;

engaging and receiving a collet and key assembly defined on the stem with one or more piston guides defined on a sleeve arranged within the shroud;

rotationally aligning with the one or more piston guides the collet and key assembly with the plurality of engagement locations; and advancing the collet and key assembly within the one or more piston guides until axially and rotationally locking the collet and key assembly with at least one of the plurality of engagement locations.