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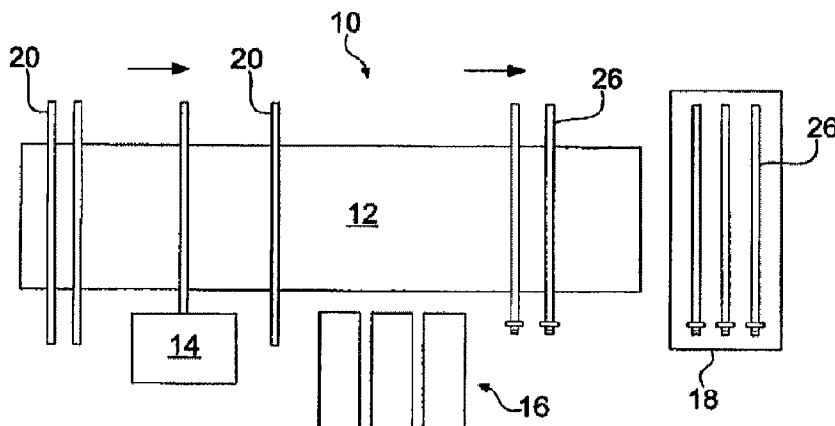
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(54) Title: SYSTEM AND METHOD OF PRODUCING MINE ROOF BOLTS



(57) Abrégé/Abstract:

A method of producing a mine roof bolt includes: providing a plurality of bars of a predetermined length, moving the plurality of bars along a conveyor and indexing the position of the plurality of bars, and passing a portion of each of the bars through a processing station, where the processing station comprises at least one of a header assembly, an extruder assembly, and a threading assembly. The method further includes processing a portion of each of the bars with the processing station. A system for producing a mine roof bolt includes a conveyor configured to index and transport a bar, a feed arrangement configured to continuously deliver bars to the conveyor, a processing station comprising at least one of a header assembly, an extruding assembly, and a threading assembly, where the processing station is positioned along the conveyor and configured to receive and process a portion of the bars.

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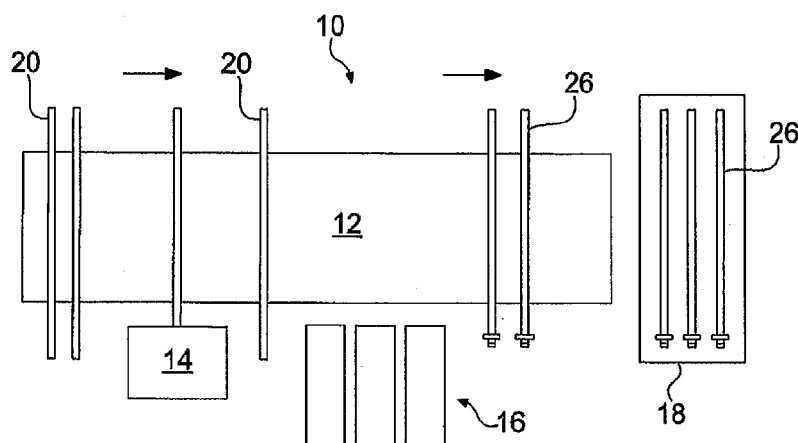


FIG. 1

(57) Abstract: A method of producing a mine roof bolt includes: providing a plurality of bars of a predetermined length, moving the plurality of bars along a conveyor and indexing the position of the plurality of bars, and passing a portion of each of the bars through a processing station, where the processing station comprises at least one of a header assembly, an extruder assembly, and a threading assembly. The method further includes processing a portion of each of the bars with the processing station. A system for producing a mine roof bolt includes a conveyor configured to index and transport a bar, a feed arrangement configured to continuously deliver bars to the conveyor, a processing station comprising at least one of a header assembly, an extruding assembly, and a threading assembly, where the processing station is positioned along the conveyor and configured to receive and process a portion of the bars.

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SYSTEM AND METHOD OF PRODUCING MINE ROOF BOLTS

[0001]

BACKGROUND OF THE INVENTION

Field of the Invention

Description of Related Art

[0002] Mine roof bolts are used to reinforce unsupported rock formations adjacent to a mine opening. In particular, the roof of a mine is conventionally supported by tensioning the roof with steel bolts inserted into bore holes drilled in the mine roof that reinforce the unsupported rock formation above the mine roof. The mine roof bolt may be anchored mechanically to the rock formation by engagement of an expansion assembly on the distal end of the mine roof bolt with the rock formation. Alternatively, the mine roof bolt may be adhesively bonded to the rock formation with a resin bonding material inserted into the bore hole. A combination of mechanical anchoring and resin bonding may also be employed by using both an expansion assembly and resin bonding material.

[0003] A mechanically anchored mine roof bolt typically includes an expansion assembly threaded onto a distal threaded end of the bolt shaft and a drive head for rotating the bolt. A mine roof plate is positioned between the drive head and the mine roof surface. The expansion assembly generally includes a multi-prong shell supported by a threaded ring and a plug threaded onto the end of the bolt. When the prongs of the shell engage with rock surrounding a bore hole, and the bolt is rotated about its longitudinal axis, the plug threads downwardly on the shaft to expand the shell into tight engagement with the rock thereby placing the bolt in tension between the expansion assembly and the mine roof surface.

[0004] When resin bonding material is utilized, the bonding material penetrates the surrounding rock formation to adhesively join the rock strata and to firmly hold the roof bolt within the bore hole. Resin is typically inserted into the mine roof bore hole in the form of a two component plastic cartridge having one component containing a curable resin composition and another component containing a curing agent (catalyst). The two component resin cartridge is inserted into the blind end of the bore hole and the mine roof bolt is inserted into the bore hole such that the end of the mine roof bolt ruptures the two component resin cartridge. Upon rotation of the mine roof bolt about its longitudinal axis,

the compartments within the resin cartridge are shredded and the components are mixed. The resin mixture fills the annular area between the bore hole wall and the shaft of the mine roof bolt. The mixed resin cures and binds the mine roof bolt to the surrounding rock. The mine roof bolt is typically rotated via a drive head. With bolts that are point anchored and tensioned, a breakaway nut may be used to rotate the bolt and subsequently tension the bolt upon curing of the resin bonding material.

SUMMARY OF THE INVENTION

[0005] In one embodiment, a method of producing a mine roof bolt includes providing a plurality of bars of a predetermined length, moving the plurality of bars along a conveyor and indexing the position of the plurality of bars, and passing a portion of each of the plurality of bars through a processing station, where the processing station comprises at least one of a header assembly, an extruder assembly, and a threading assembly. The method further includes processing a portion of each of the plurality of bars with the processing station.

[0006] The method may further include where a longitudinal and lateral position of the plurality of bars is indexed. The processing station may include a header assembly, and processing the portion of each of the plurality of bars may include: heating a portion of a first bar of the plurality of bars; passing the portion of the first bar through the header assembly; and forging a head at an end of the first bar. The method may further include actuating clamping assemblies to fix the position of the first bar during forging. The processing station may include an extruder assembly, and processing the portion of each of the plurality of bars may include: passing a portion of a first bar of the plurality of bars through the extruder assembly; actuating a die cylinder to move a die holder assembly toward the first bar; and extruding a portion of the first bar. The method may include, after extruding the portion of the first bar, moving the first bar along the conveyor toward a second extruder assembly, passing the portion of the first bar of the plurality of bars through the second extruder assembly, actuating a die cylinder to move a die holder assembly toward the first bar, and further extruding the portion of the first bar. The method may include moving each of the plurality of bars from a feed rack to the conveyor using a feed delivery device. The movement of the conveyor and the feed delivery device may be synchronized. The method may include, after processing the portion of the bar, continuing to move the bar along the conveyor and depositing each of the plurality of bars into a receptacle.

[0007] In a further embodiment, a system for producing a mine roof bolt includes a conveyor configured to index and transport a bar, a feed arrangement configured to

continuously deliver bars to the conveyor, a processing station comprising at least one of a header assembly, an extruding assembly, and a threading assembly. The processing station is positioned along the conveyor and configured to receive and process a portion of the bars.

[0008] The feed arrangement may include a feed rack and a feed wheel positioned adjacent to the feed rack with the feed wheel configured to receive bars from the feed rack and to deliver the bars to the conveyor. The conveyor may include a drive member and at least two drive sprockets with the drive member forming a continuous loop and extending circumferentially around the at least two drive sprockets. The drive member may include a plurality of indexing clamps with the plurality of indexing clamps configured to receive the bars and index a lateral position of the bars relative to adjacent bars. The system may further include a heating source configured to heat a portion of the bar and the processing station may be a header assembly. The header assembly may include a frame assembly, upper and lower clamp assemblies, and at least one header die assembly with the upper and lower clamp assemblies configured to engage a portion of the bar. The at least one header die assembly may include a die cylinder, a die holder, and a tool received by the die holder with the die holder moveable between a retracted and extended position via the die cylinder. The header assembly is configured to form a head at an end of the bar. The processing station may be an extruder assembly with the extruder assembly including a frame assembly, upper and lower clamp assemblies, and at least one extruder die assembly. The upper and lower clamp assemblies are configured to engage a portion of the bar. The at least one extruder die assembly may include a die cylinder, a die holder, and a tool received by the die holder with the die holder moveable between a retracted and extended position via the die cylinder. The extruder assembly is configured to extrude a portion of the bar.

[0009] The processing station may be a threading assembly that includes a frame assembly, a moving die assembly, and a stationary die assembly with the moving die assembly movable relative to the frame assembly and the stationary die assembly via a threading die cylinder. The moving die assembly and the stationary die assembly are configured to form threads on a portion of the rod. The threading assembly may further include a support stand having first and second paddles with the first and second paddles each configured to initially support the rod prior to forming threads on a portion of the rod. The first and second paddles are movable in a downward direction. The system may further include an index cylinder and a stop plate that are configured to index the longitudinal position of a bar positioned on the conveyor with the index cylinder moveable between first and second positions and configured to move a bar until the bar contacts the stop plate. The system may further include

a receptacle positioned adjacent to an end of the conveyor with the plurality of indexing clamps configured to release the bars and deposit the bars into the receptacle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Fig. 1 is a top schematic view of a system and method of producing a mine roof bolt according to one embodiment of the present invention.

[0011] Fig. 2A is a front view of a conventional mine roof bolt.

[0012] Fig. 2B is a bottom view of the mine roof bolt shown in Fig. 2A.

[0013] Fig. 3 is a front perspective view of an extruder assembly according to one embodiment of the present invention.

[0014] Fig. 4 is a rear perspective view of the extruder assembly shown in Fig. 3.

[0015] Fig. 5 is a front view of the extruder assembly shown in Fig. 3.

[0016] Fig. 6 is a top view of the extruder assembly shown in Fig. 3.

[0017] Fig. 7 is a partial rear perspective view of the extruder assembly shown in Fig. 3.

[0018] Fig. 8 is a partial right side view of the extruder assembly shown in Fig. 3.

[0019] Fig. 9 is a cross-sectional view of the extruder assembly shown in Fig. 3.

[0020] Fig. 10 is an exploded perspective view of an extruder die holder assembly according to one embodiment of the present application.

[0021] Fig. 11 is cross-sectional view of the extruder die holder assembly shown in Fig. 10.

[0022] Fig. 12 is a perspective view of a header assembly according to one embodiment of the present invention.

[0023] Fig. 13 is a rear perspective view of the header assembly shown in Fig. 12.

[0024] Fig. 14 is an exploded perspective view of a header die assembly according to one embodiment of the present invention.

[0025] Fig. 15 is a right perspective view of a threading assembly according to one embodiment of present invention.

[0026] Fig. 16 is a left perspective view of the threading assembly shown in Fig. 15.

[0027] Fig. 17 is a top view of the threading assembly shown in Fig. 15.

[0028] Fig. 18 is a right rear perspective view of the threading assembly according to one embodiment of the present invention.

[0029] Fig. 19 is a front schematic view of a feed and indexing assembly according to one embodiment of the present invention.

[0030] Fig. 20 is a top schematic view of the feed and indexing assembly shown in Fig. 19.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] For purposes of the description hereinafter, the terms “upper”, “lower”, “right”, “left”, “vertical”, “horizontal”, “top”, “bottom”, and derivatives thereof, shall relate to the invention as it is oriented in the drawing figures. However, it is to be understood that the invention may assume various alternative variations and step sequences, except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification, are simply exemplary embodiments of the invention. Hence, specific dimensions and other physical characteristics related to the embodiments disclosed herein are not to be considered as limiting.

[0032] Referring to Fig. 1, one embodiment of a system 10 for producing a mine roof bolt includes a conveyor 12, a heating source 14, a processing station 16, and a cradle or receptacle 18 for receiving finishing product. Raw bars 20, such as rebar, are fed to a first end of the conveyor 12. The bars 20 may be placed in a holding rack and picked up through a bar separator that will index and position the bars 20 on the conveyor 12. The bars 20 are fed into the heating source 14, such as an induction heating coil, and a predetermined portion of each bar 20 is heated to an appropriate forging temperature. The bars 20 are then indexed along the conveyor 12 and moved to the processing station 16 for further processing. One embodiment of the feed and indexing assembly, which provides bars 20 from a holding rack and indexes the position of the bars 20, is discussed in more detail below and shown in Figs. 19 and 20. The processing station 16 may be a hydraulic forging assembly that forms a head on an end of the bar 20, which is discussed in more detail below. After being processed at the processing station 16, the bars 20 are moved to a discharge position that will deposit the finished bars in the cradle 18 for collection and movement to further processing. Such further processing may include extrusion and/or threading processes, which are also discussed in more detail below. Further, although Fig. 1 only shows a single processing station 16, the system 10 may include one or more processing stations 16 that are automated to allow raw bar material to be fed and indexed on the conveyor 12 and processed by the one or more processing stations 16 to provide a finished mine roof bolt.

[0033] Referring to Figs. 2A and 2B, the system 10 shown in Fig. 1 may be utilized to produce a mine roof bolt 26 having a head 28 formed on a first end 30 that is positioned opposite from a second end 32. The head 28 includes a flange 34 and a four-sided square-shaped protrusion 36 that is configured to engage a drive tool, although the system may be used to form other types of head configurations. The mine roof bolt 26 may also be further

processed by extruding the second end 32 and/or threading the second end 32 of the mine roof bolt 26. The threaded second end (not shown) may be used to receive an expansion assembly (not shown) as noted in the background section above. Rather than providing an integral head on the first end 30 of the mine roof bolt 26, the first end 30 of the mine roof bolt 26 may be extruded and threaded so that the first end 30 can receive a nut (not shown) or other suitable tensioning arrangement.

[0034] Referring to Figs. 3-11, one embodiment of the processing station 16 includes an extruder assembly 40. The extruder assembly 40 performs a cold extrusion process and does not require the heating source 14 shown in Fig. 1, although the extruder assembly 40 may also be utilized in hot extrusion process where the heating source 14 is needed. The extruder assembly 40 is used to extrude the first and/or second ends 30, 32 of the mine roof bolt 26 to form a smooth surface. The extruder assembly 40 includes a frame assembly 42 and first, second, and third extruder die assemblies 44, 46, 48. The frame assembly 42 includes four spaced apart frame plates 52 that are secured together. Each frame plate 52 is generally square-shaped and defines first and second openings 54, 56. The frame plates 52 are secured to each other with a frame support plate 58 that is received by the first opening 54 of each frame plate 52 with the frame support plate 58 extending perpendicularly between the frame plates 52. The frame support plate 58 is secured to the frame plates 52 with angle brackets 60. The frame plates 52 are also secured to each other via first and second grip plates 62, 64. The second opening 56 of each frame plate 52 is configured to allow mine roof bolts 26 to be received by the extruder assembly 40. Further, as shown more clearly in Fig. 7, a plurality of spacer plates 66 is positioned between adjacent frame plates 52.

[0035] Referring still to Figs. 3-11, the extruder die assemblies 44, 46, 48 each include a die cylinder 68, a die holder assembly 70, and upper and lower clamping assemblies 72, 74. The die cylinders 68 and die holder assemblies 70 are each supported by respective die support plates 76 that are received by the frame support plates 58 and generally extend parallel to the frame plates 52. Each die cylinder 68 includes a die cylinder rod 78 that is secured to the respective die holder assemblies 70. The die cylinder rod 78 can be actuated between a retracted and fully extended position with corresponding movement of the respective die holder assembly 70. The die cylinder 68 is a hydraulic cylinder, although other suitable arrangements for displacing the die holder assembly 70 may be utilized. Each of the upper clamping assemblies 72 includes an upper cylinder 80 and an upper grip 82 secured to the upper cylinder 80 via an upper cylinder rod 84. Each of the lower clamping assemblies 74 includes a lower cylinder 86 and a lower grip 88 secured to the lower cylinder 86 via a

lower cylinder rod 90. The upper and lower cylinders 80, 86 can be actuated to move the upper and lower grips 82, 88 between a spaced position and a clamping position. In particular, the upper and lower cylinders 80, 86 are configured to be actuated to apply a clamping force to the mine roof bolt 26 to securely hold the mine roof bolt 26 while being processed.

[0036] Referring to Figs. 8-11, each of the die holder assemblies 70 includes a body 92, an insert holder 94 and insert 96 received within the body 92, and a cover plate 98. The body 92 defines an internal passageway 100 having a first end 102 for receiving an end of the die cylinder rod 78 and a second end 104 for receiving the insert holder 94 and insert 96. Each of the die holder assemblies 70 further includes a pair of side rollers 106 and an upper roller 108. The pair of side rollers 106 is received by respective spaced apart lower tracks 110 positioned on the die support plates 76. The upper roller 108 of each die holder assembly 70 is received by a respective upper track 112 positioned on a track support plate 114 that extends perpendicularly to the frame plates 52. The pair of side rollers 106 and the upper roller 108 allows each die holder assembly 70 to be supported and to be freely moveable between a retracted and extended position while extruding or processing the mine roof bolt 26.

[0037] Referring again to Figs. 1-11, when the bar 20 or mine roof bolt 26 reaches the extruder assembly 40 and is in a proper position, the upper and lower clamping assemblies 72, 74 are automatically actuated to hold the bar 20 securely during the extrusion process. The lower cylinder 86 is actuated to extend the lower cylinder rod 90 to full stroke to maintain constant a constant vertical or centerline of the bar 20 being extruded. The upper cylinder 80 provides a clamping force which is regulated via a pressure reduction to the upper cylinder 80. Once clamping is completed, the die cylinder 68 is actuated to move one of the die holder assemblies 70 towards the bar 20. The insert 96 of the die holder assembly 70 engages the bar 20 and completes a first step of the extrusion process. The die cylinder 68 will then retract and the upper and lower clamping cylinders 80, 86 will retract to remove the clamping force applied by the upper and lower grips 82, 88. The bar 20 is then moved to the next extruder die assembly 44, 46, 48 for further processing. The extruder assembly 40 includes three extruder die assemblies 44, 46, 48 to progressively provide the final dimensioning and processing of the bar 20. The extruder assembly 40, however, may include one or more extruder die assemblies. After finishing the extrusion process, the bars 20 or mine roof bolts 26 are moved to the discharge position and deposited into the cradle 18 for collection and/or further processing.

[0038] Referring to Figs. 12-14, a further embodiment of the processing station 16 includes a header assembly 120. The header assembly 120 is configured to form the head 28, as described above, on the bar 20 or mine roof bolt 26. The header assembly 120 is embodied as a forging mechanism, although other suitable arrangements may be provided to form the head 28. As discussed above, the mine roof bolt 26 is heated by the heating source 14 shown in Fig. 1 before reaching the header assembly 120. The header assembly 120 may be similar to the extruder assembly 40 discussed above and shown Figs. 3-11. Although not shown, the header assembly 120 would also include the die cylinder 68 and upper and lower clamping assemblies 72, 74. The header assembly 120 also includes frame plates 122 that are different from the frame plates 52 of the extruder assembly 40, although the header assembly 120 may also utilize the same components of the extruder assembly 40 with different tooling being utilized. In particular, the frame plates 122 of the header assembly 120 are each formed with separate upper and lower portions 124, 126 that are secured to each other and to adjacent frame plates 122. Further, the frame plates 122 define a single opening 128 and are each configured to receive bars 20 or mine roof bolts 26 for the forging process. As shown more clearly in Fig. 14, the header assembly 120 includes first and second cone assemblies 130, 132 and an insert assembly 134 rather than the extruder die assemblies 44, 46, 48 of the extruder assembly 40. Each cone assembly 130, 132 includes a body 136 that receives a cone tool 138. Although shown in front of the cone tool 138, a tool spacer 140 and washer 142 are positioned behind the cone tool 138 with a cover plate 144 secured to the body 136 to fix the cone tool 138 within the body 136. Each cone assembly 130, 132 is actuated between an extended position and a retracted position in the same manner as discussed above in connection with the extruder die assemblies 44, 46, 48 of the extruder assembly 40.

[0039] Referring again to Figs. 12-14, the insert assembly 134 includes a body 146 that receives an insert back plate 148, an insert holder 150, and an insert 152. The insert 152 is configured to form the final dimensions of the square-shaped protrusion 36 of the head 28 shown in Figs. 2A and 2B, although other inserts 152 may be utilized to form a variety of head shapes and sizes. The body 146 further receives a stencil holder 154, a stencil back plate 156, and a stencil 158. The stencil 158 is configured to provide product identification or other information on the head 28 of the mine roof bolt 26. A pair of clamps 160 is used to secure the insert 152, stencil 158, and other components within the body 146 of the insert assembly 134. The bars 20 or mine roof bolts 26 may be fed through the header assembly 120 in the same manner as discussed above in connection with the extruder assembly 40. The head 28 of the mine roof bolt 26 may be formed by first and second forging processes

performed by the first and second cone assemblies 130, 132 to progressively form a cone shape on an end of the bar 20 and a third forging process performed by the insert assembly 134 to provide the final shape and dimension of the head 28 shown in Figs. 2A and 2B. The header assembly 120, however, may include one or more forging processes to provide the final head shape and size.

[0040] Referring to Figs. 15-18, another embodiment of the processing station 16 includes a threading assembly 162. The threading assembly 162 is configured to thread a portion of the mine roof bolt 26, such as an end of the mine roof bolt 26. The threading machine 162 generally includes a frame assembly 164, a moving die assembly 166, and a stationary die assembly 168. The frame assembly 164 includes three frame plates 170 secured to a base plate 172, a back plate 174, and a front plate 176. The front plate 176 defines an opening 178 that is configured to receive a portion of the mine roof bolt 26. The frame assembly 164 also includes removable gusset plates 180 and a gusset base plate 182. The moving die assembly 166 is movable relative to the frame assembly 164 and the stationary die assembly 168 via a die cylinder 184. The die cylinder 184 may be a hydraulic cylinder, although other suitable arrangements for moving the moving die assembly 166 may be utilized. The moving die assembly 166 includes a moving die block 186 and a moving die 188 that is received by the moving die block 186. The moving die block 186 and moving die 188 are moved vertically between a retracted position and an extended position along a track formed by a frame track 190 secured to the back plate 174 and a die track 192 secured to the moving die block 186. The stationary die assembly 168 is fixed relative to the frame assembly 164 and includes a stationary die block 194 and a stationary die 196 received by the stationary die block 194.

[0041] Referring again to Figs. 15-18, the threading assembly 162 also includes a support stand 198 having first and second paddles 202, 204 that are each configured to receive the mine roof bolt 26 for positioning the mine roof bolt 26 between the moving and stationary dies 188, 196. The first and second paddles 202, 204 are also configured to pivot downwardly when engaged and return to their original position. The first and second paddles 202, 204 may include a spring mechanism (not shown) to return the paddles 202, 204 to their original position after pivoting downward. The threading assembly 162 includes a pusher member 206 that is moveable between a retracted and extended position by a pusher cylinder 208. The pusher member 206 is moved to the extended position and is configured to engage a mine roof bolt 26 positioned on the first and second paddles 202, 204. The pusher member 206 further causes the paddles 202, 204 to pivot downward and ensures that the mine roof bolt 26 is positioned between the moving and stationary dies 188, 196 once the threading

operation is commenced. The threading assembly 162 is configured to receive the mine roof bolt 26 between the stationary die 196 and the moving die 188 and moving the moving die 188 to roll the mine roof bolt 26 and form threads on a portion of the mine roof bolt 26. The end of the mine roof bolt 26 to be threaded may be fed through the opening 178 in the front plate 176 and supported by the paddles 202, 204 of the support stand 198.

[0042] Referring still to Figs. 15-18, the mine roof bolt 26 is rolled between the moving die 188 and the stationary die 196 to form threads on a portion of the mine roof bolt 26 and is deposited onto the base plate 172 at the bottom of the threading assembly 162. The gusset plates 180 are configured to support the threading assembly 162 as a stand alone unit. However, the gusset plates 180 may be removed and the threading assembly 162 can be secured attached to one of the other processing stations 40, 120. In particular, the front plate 176 of the threading assembly 162 can be secured attached to one of the frame plates 52 of the extruder assembly 40 to provide continuous throughput of the mine roof bolts 26. After being threaded, the mine roof bolts 26 may be carried by a conveyor arrangement (not shown) from the threading machine to a packaging area or further processing area.

[0043] Referring to Figs. 19 and 20, one embodiment of a feed and indexing assembly 212 includes a feed rack 214, a feed wheel 216, a drive member 218, drive sprockets 220, and indexing clamps 222. The feed rack 214 is configured to provide a continuous feed of bars 20 to the feed wheel 216. The feed wheel 216 is generally disc-shaped and includes a plurality of notches 224 that are configured to receive the bars 20. The feed wheel 216 continuously rotates and receives bars 20 in the notches 224, which are fed from the feed rack 214. The feed wheel 216 feeds the bars 20 to the conveyor 12 shown in Fig. 1. The conveyor 12 is embodied as the drive member 218 mounted on the drive sprockets 220. The drive member 218 may be a drive chain, although other suitable arrangements may be utilized for the drive member 218. A plurality of drive members 218 and a plurality of drive sprockets 220 may be utilized to support the bars 20 or mine roof bolts 26 at each end. The drive sprockets 220 are driven and rotated to move the bars 20 or mine roof bolts 26 along the conveyor 12 and through the various processing stations 16. The drive sprockets 220 may be driven via an electric motor, although other suitable arrangements may be utilized to drive the drive sprockets 220. The drive member 218 may include a plurality of sets of indexing clamps 222 that receive the bars 20 from the feed wheel 216 and position the bars 20 a predetermined lateral distance apart from each other. The indexing clamps 222 are secured to the drive member 218 and are configured to be spaced apart as they rotate about the drive sprockets 220. In particular, as shown in Fig. 19, the indexing clamps 222 separate as they

rotate around the drive sprocket 220 and receive the bar 20 from the feed wheel 216. As the indexing clamps 222 move beyond the drive sprocket 220, the indexing clamps 222 are moved back together to receive and index the bars 20.

[0044] Referring to Fig. 20, the feed and indexing assembly 212 further includes an index cylinder 226 and a stop plate 228 that are configured to index the longitudinal position of the bars 20 or mine roof bolts 26. The index cylinder 226 includes an engagement 230 that is moveable between first and second positions and is configured to engage the bars 20 and move them in a longitudinal direction. In particular, the bars 20 are engaged by the engagement 230 of the index cylinder 226 until the bars 20 abut the stop plate 228 to ensure that the bars 20 have a proper longitudinal orientation before entering the processing stations 16.

[0045] Although the invention has been described in detail for the purpose of illustration based on what is currently considered to be the most practical and preferred embodiments, it is to be understood that such detail is solely for that purpose and that the invention is not limited to the disclosed embodiments but, on the contrary, is intended to cover modifications and equivalent arrangements that are within the spirit and scope of the description. For example, it is to be understood that the present invention contemplates that, to the extent possible, one or more features of any embodiment can be combined with one or more features of any other embodiment.

What is claimed is

1. A method of producing a mine roof bolt comprising:
providing a plurality of bars of a predetermined length;
moving the plurality of bars along a conveyor and indexing a position of the plurality of bars;
passing a portion of each of the plurality of bars through a processing station, wherein the processing station comprises a header assembly, along with at least one of an extruder assembly and a threading assembly;
processing a portion of each of the plurality of bars with the processing station to form a plurality of mine roof bolts;
moving the mine roof bolts along the conveyor and depositing each of the plurality of mine roof bolts into a receptacle;
wherein processing the portion of each of the plurality of bars comprises:
heating a portion of a first bar of the plurality of bars;
passing the portion of the first bar through the header assembly;
forging a head at an end of the first bar; and
actuating clamping assemblies to fix a position of the first bar during forging.
2. The method of claim 1, wherein a longitudinal and lateral position of the plurality of bars is indexed.
3. The method of claim 1 or claim 2, wherein the processing station comprises an extruder assembly, and wherein processing the portion of each of the plurality of bars comprises:
passing a portion of a first bar of the plurality of bars through the extruder assembly;
actuating a die cylinder to move a die holder assembly toward the first bar; and
extruding a portion of the first bar.
4. The method of claim 3, further comprising:
after extruding the portion of the first bar, moving the first bar along the conveyor toward a second extruder assembly;
passing the portion of the first bar of the plurality of bars through the second extruder assembly;

actuating a die cylinder to move a die holder assembly toward the first bar; and further extruding the portion of the first bar.

5. The method of any one of claims 1 to 4, wherein providing the plurality of bars comprises:

moving each of the plurality of bars from a feed rack to the conveyor using a feed delivery device.

6. A system for producing a mine roof bolt comprising:

a conveyor configured to index and transport bars;

a feed arrangement configured to continuously deliver the bars to the conveyor; and

a processing station comprising a heating source for heating at least a portion of the bars and a header assembly for forming a head onto each of the bars,

wherein the processing station is positioned along the conveyor and configured to receive and process a portion of each of the bars to form a mine roof bolt, wherein the conveyor comprises a drive member including a plurality of indexing clamps, the plurality of indexing clamps being configured to receive the bars and index a lateral position of the bars relative to adjacent bars, and

wherein the feed arrangement comprises a feed rack and a feed wheel positioned adjacent to the feed rack, the feed wheel configured to receive the bars from the feed rack and to deliver the bars to the conveyor.

7. The system of claim 6, wherein the conveyor further comprises at least two drive sprockets, and wherein the drive member forms a continuous loop and extends circumferentially around the at least two drive sprockets.

8. The system of claim 6 or claim 7, wherein the header assembly comprises:

a frame assembly, upper and lower clamp assemblies, and at least one header die assembly, the upper and lower clamp assemblies configured to engage a portion of each of the bars, the at least one header die assembly comprising a die cylinder, a die holder, and a tool received by the die holder, the die holder moveable between a retracted and extended position via

the die cylinder, wherein the header assembly is configured to form a head at an end of each of the bars.

9. The system of claim 6 or claim 7, wherein the processing station comprises an extruder assembly, the extruder assembly comprising:

a frame assembly, upper and lower clamp assemblies, and at least one extruder die assembly, the upper and lower clamp assemblies configured to engage a portion of each of the bars, the at least one extruder die assembly comprising a die cylinder, a die holder, and a tool received by the die holder, the die holder moveable between a retracted and extended position via the die cylinder, wherein the extruder assembly is configured to extrude a portion of each of the bars.

10. The system of claim 6 or claim 7, wherein the processing station further comprises a threading assembly, the threading assembly comprising:

a frame assembly, a moving die assembly, and a stationary die assembly, the moving die assembly is movable relative to the frame assembly and the stationary die assembly via a threading die cylinder, the moving die assembly and the stationary die assembly are configured to form threads on a portion of each of the bars.

11. The system of claim 10, wherein the threading assembly further comprises a support stand having first and second paddles, the first and second paddles are each configured to initially support each of the bars prior to forming threads on a portion of each of the bars, the first and second paddles are movable in a downward direction.

12. The system of any one of claims 6 to 11, further comprising an index cylinder and a stop plate that are configured to index a longitudinal position of each of the bars positioned on the conveyor, the index cylinder moveable between first and second positions and configured to move each of the bars until each of the bars contacts the stop plate.

13. The system of any one of claims 6 to 12, further comprising a receptacle positioned adjacent to an end of the conveyor, the plurality of indexing clamps is configured to release each of the bars and deposit each of the bars into the receptacle.

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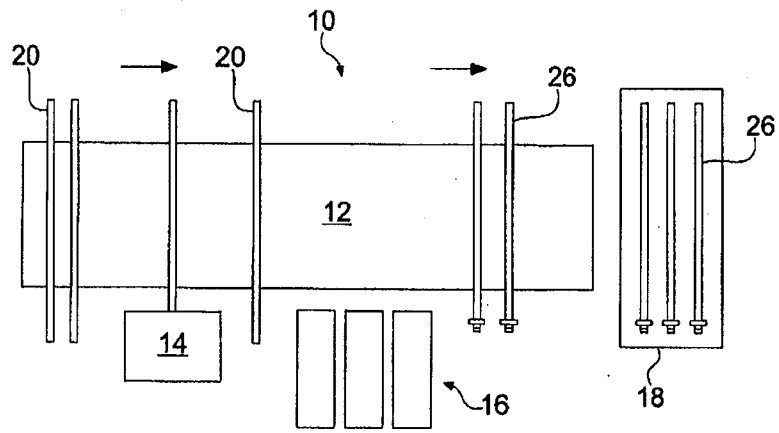
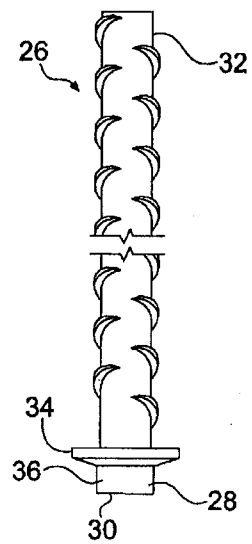
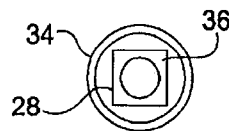


FIG. 1

FIG. 2A
(PRIOR ART)FIG. 2B
(PRIOR ART)

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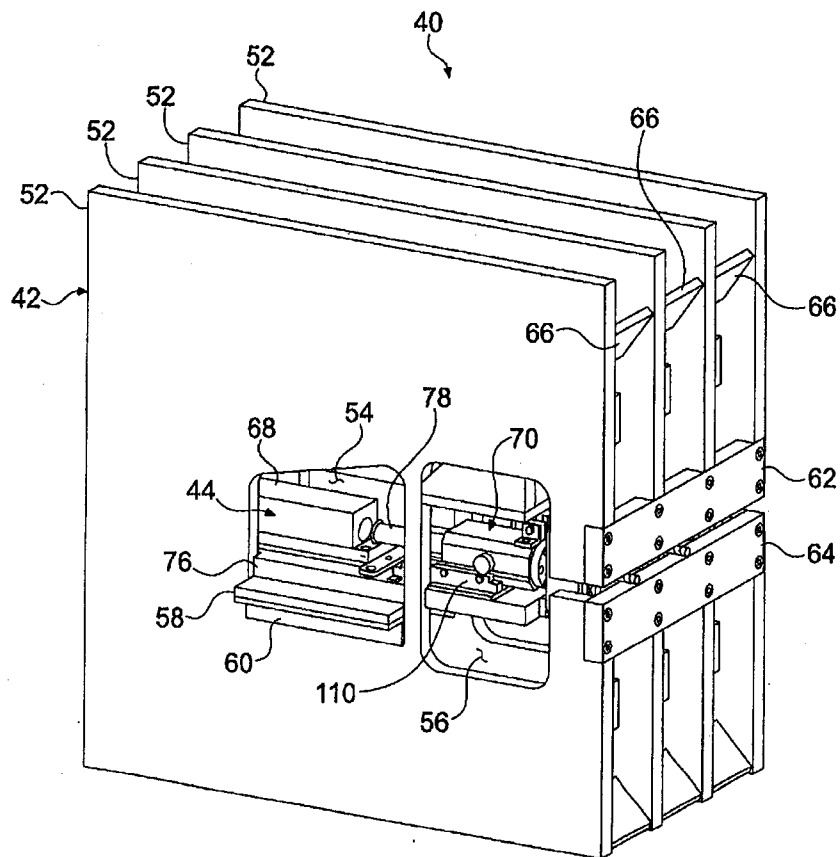


FIG. 3

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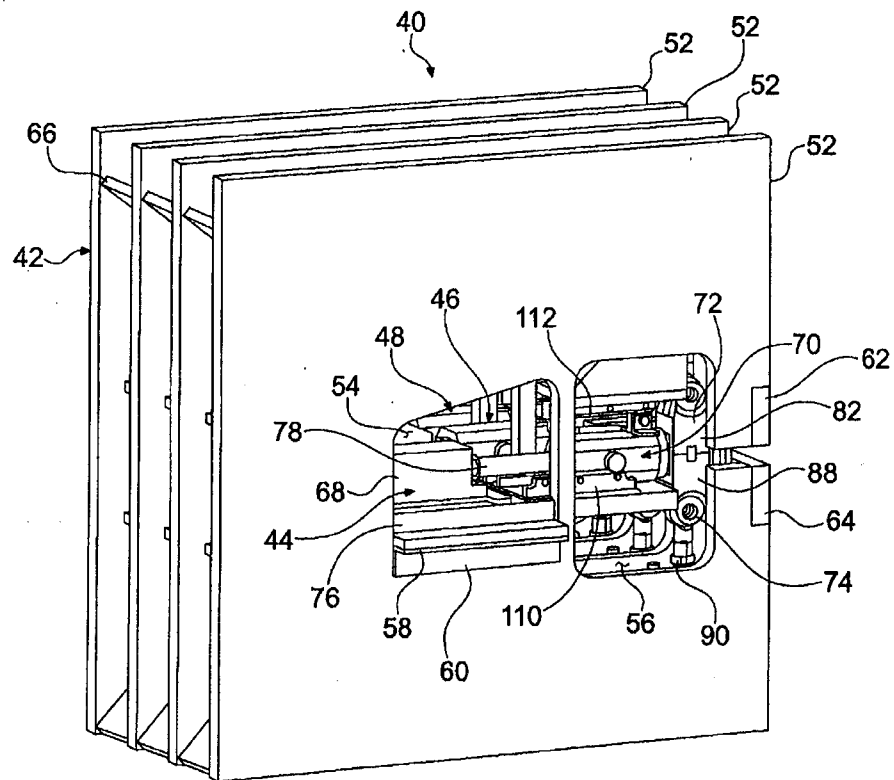


FIG. 4

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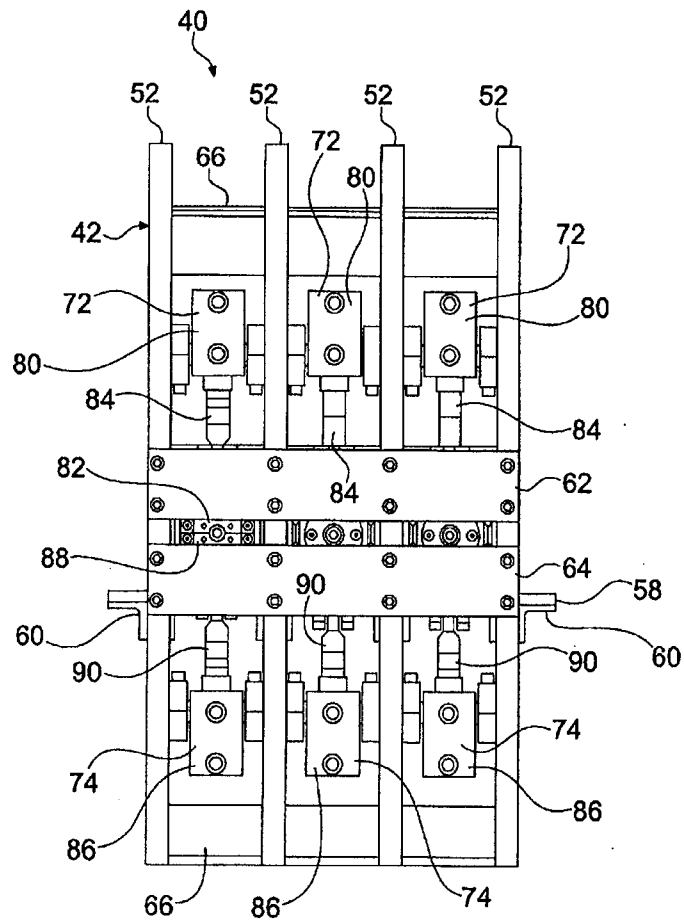
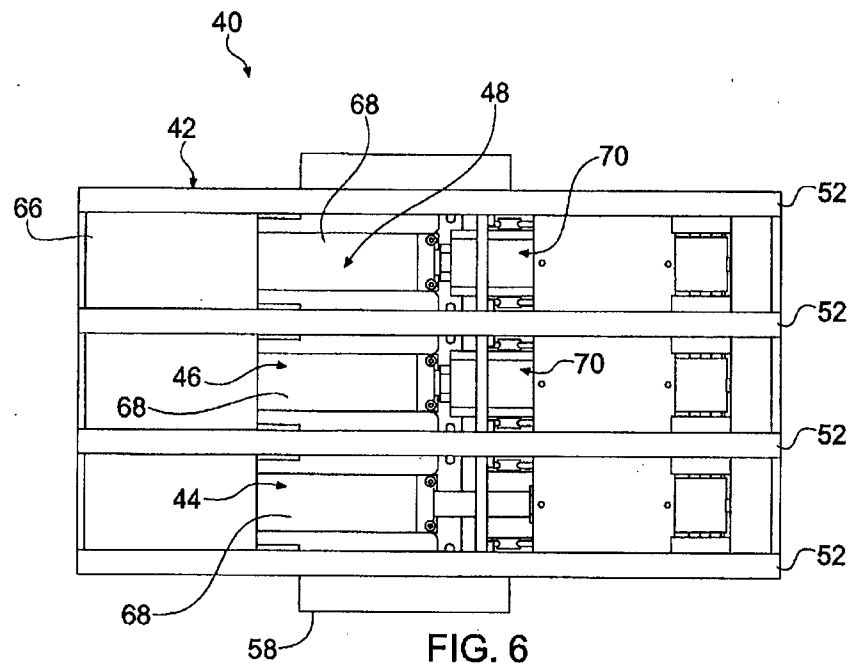
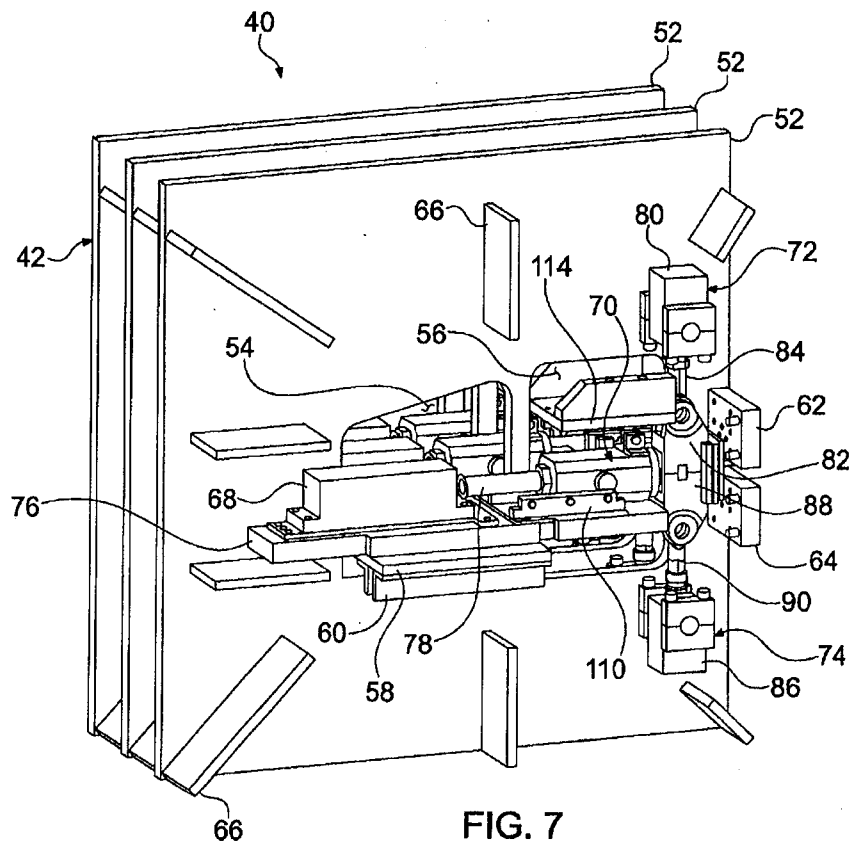


FIG. 5

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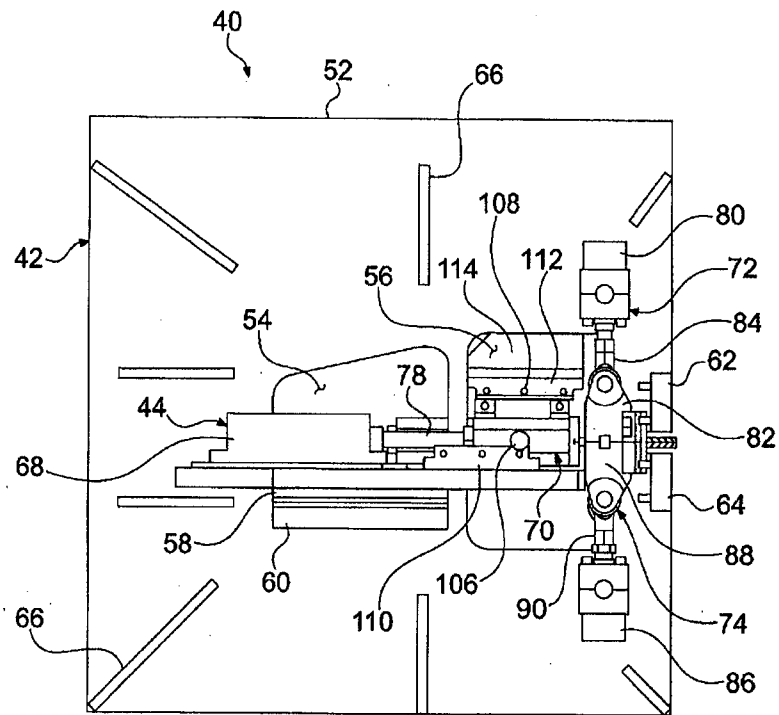


FIG. 8

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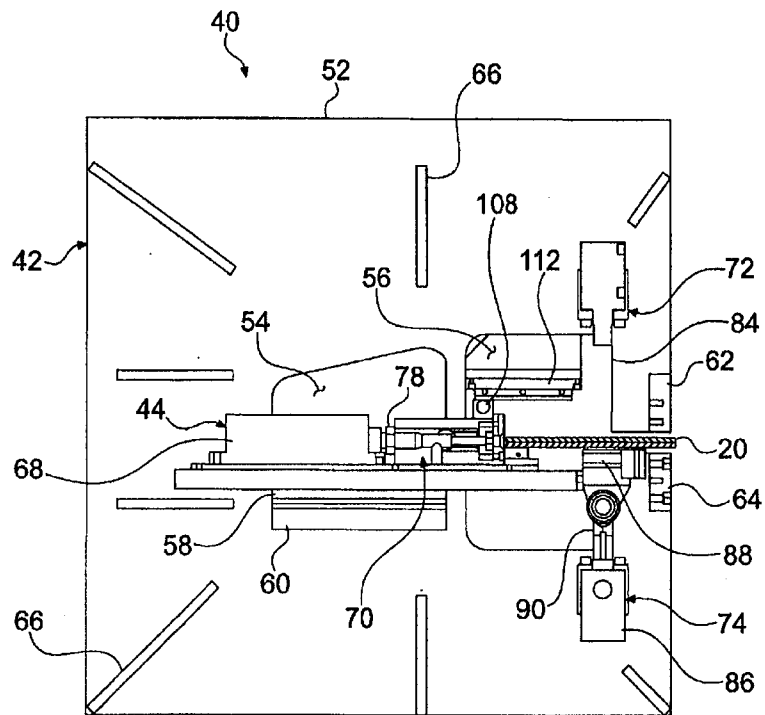


FIG. 9

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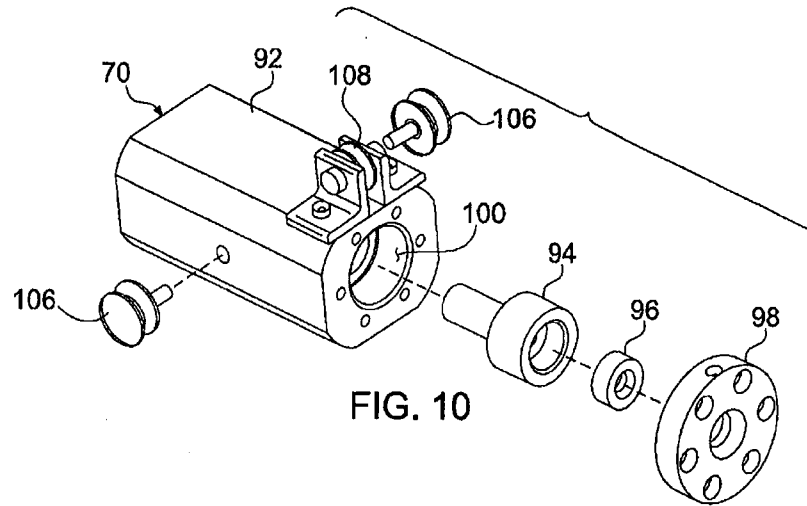


FIG. 10

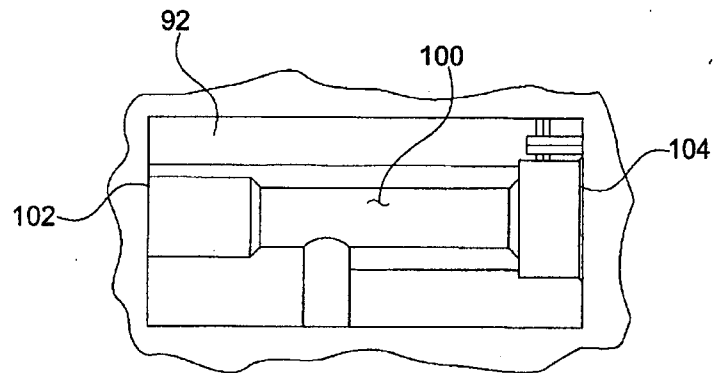


FIG. 11

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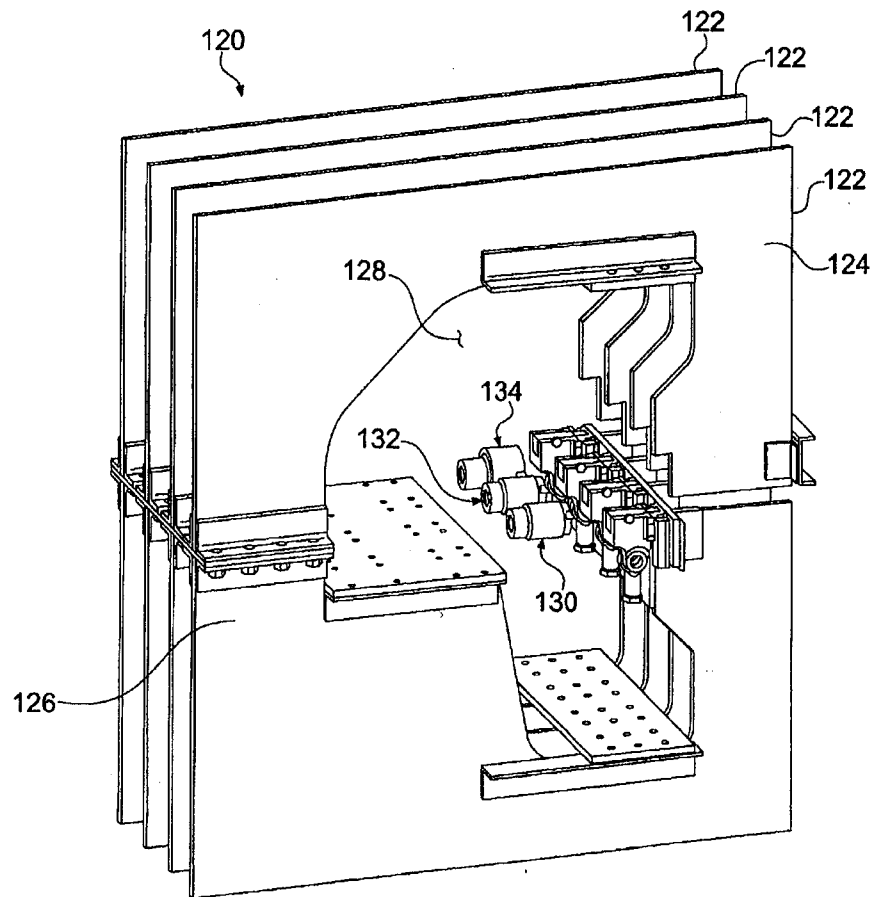


FIG. 12

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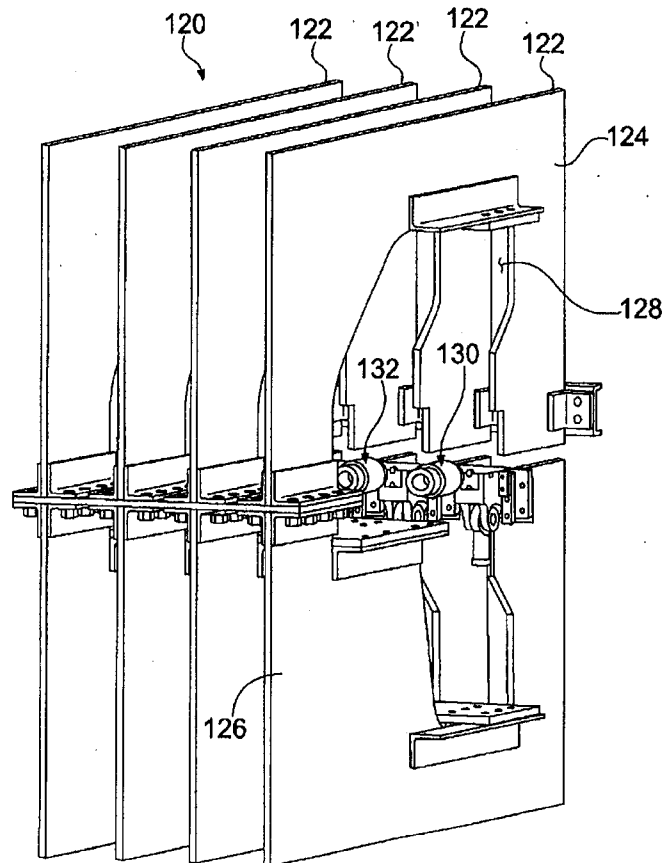
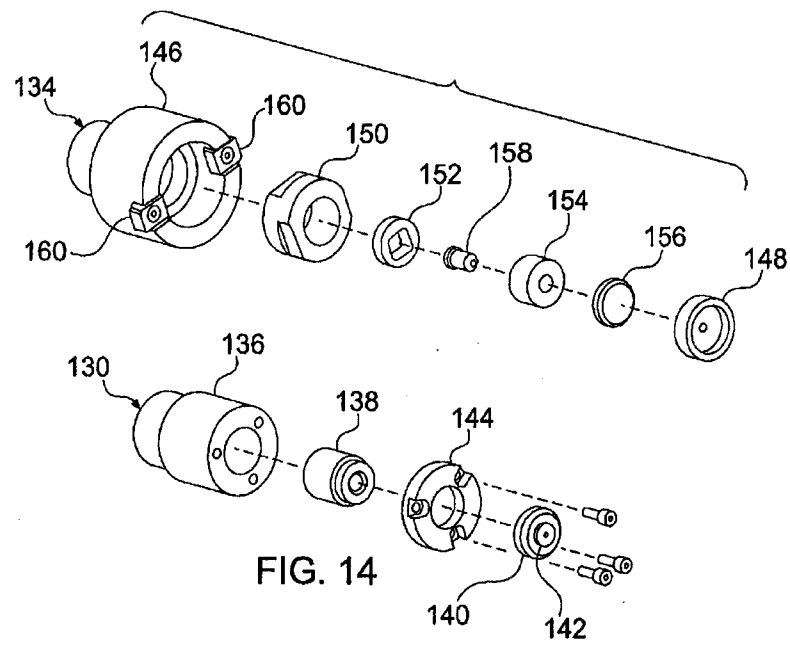
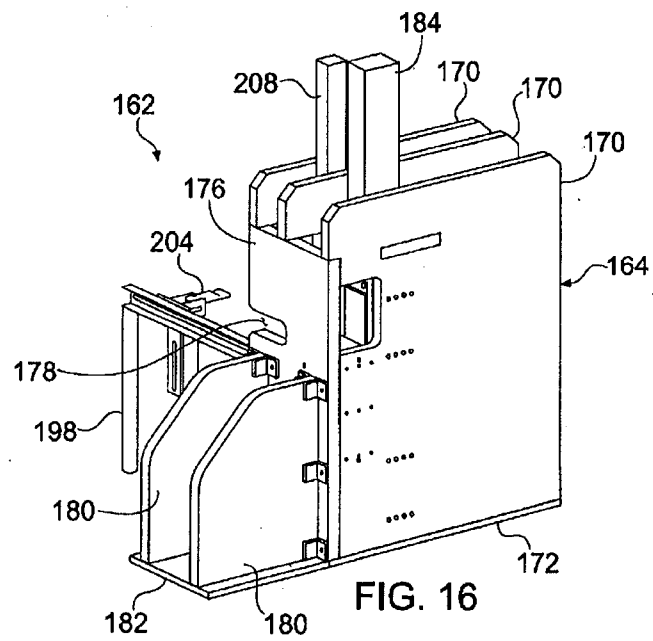
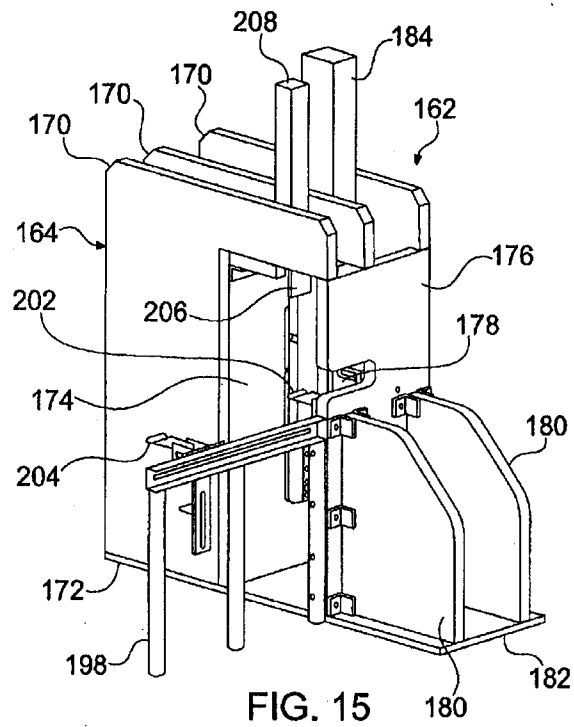


FIG. 13

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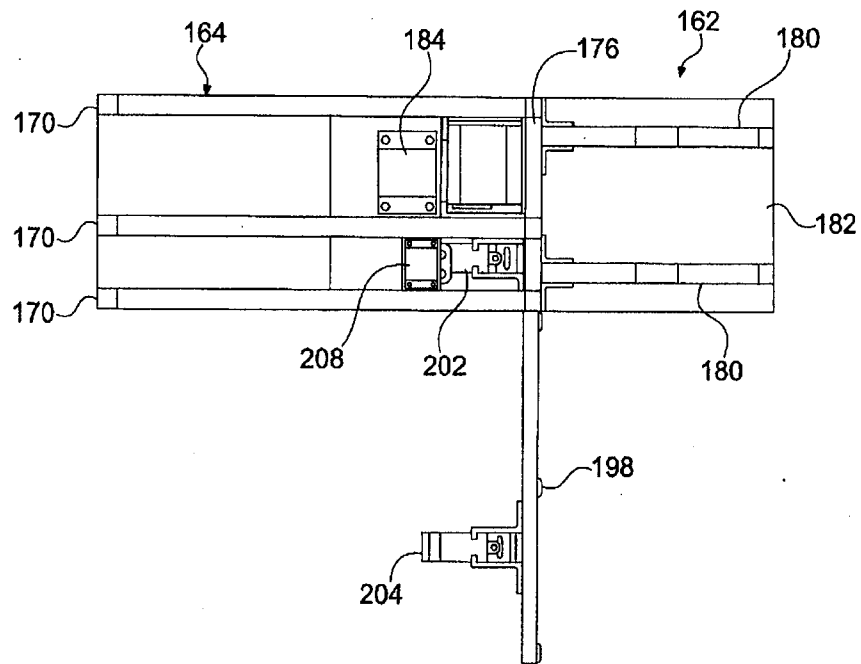


FIG. 17

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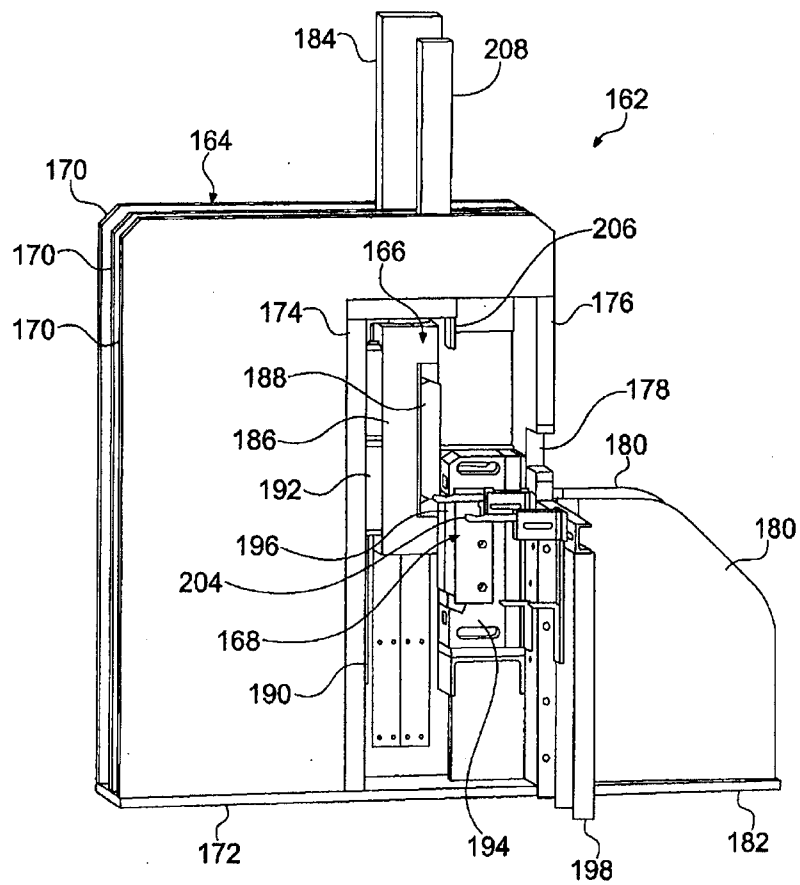


FIG. 18

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