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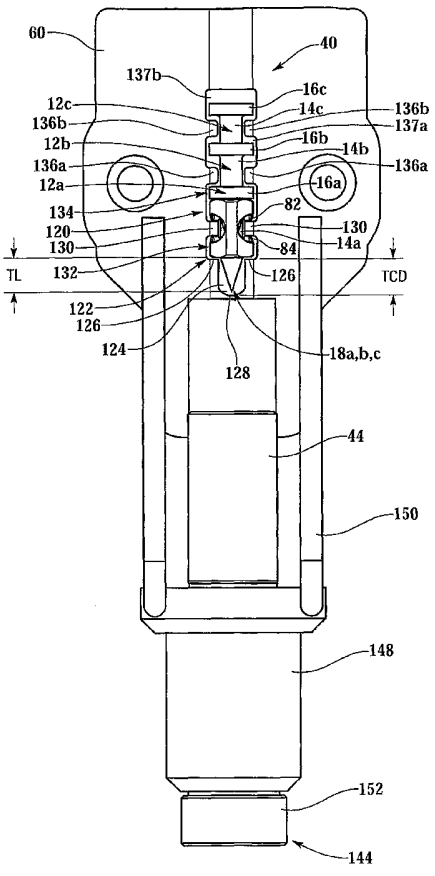
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(54) Title: COLLATIONS FOR FASTENERS OF VARIOUS LENGTHS



(57) Abstract: A collation comprises a plurality of sleeves for supporting and carrying a plurality of fasteners through a magazine, wherein each of the plurality of sleeves have a front and a predetermined length, each of the plurality of fasteners have predetermined length and a tip located at a predetermined position in relation to the sleeve front, frangible bridges integrally connecting the plurality of sleeves together in a serial array, and a plurality of protusions from the sleeves for engaging the rails in the magazine. A system of collations comprises a plurality of first collations each having a plurality of sleeves each having a front, the sleeves holding first fasteners having a tip located at a predetermined position relative to the sleeve front, and a plurality of second collations each having a plurality of second sleeves each having a front, the second sleeves holding second fasteners having a different length than the first fasteners and a tip located at the same predetermined position relative to the front of the second sleeves.

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Description

COLLATIONS FOR FASTENERS OF VARIOUS LENGTHS

BACKGROUND OF THE INVENTION

1. Field of the Invention

[1] The present invention is directed to collations for delivering fasteners to a fastener driving tool, particular to collations for holding fasteners of various lengths.

2. Description of the Related Art

[2] Different construction applications may require different fastener lengths. Prior collations typically hold the fasteners proximate their heads regardless of overall fastener length, so that long fasteners typically have a long shank portion below the collation and short fasteners typically have a short shank portion below the collation. Tools for driving fasteners typically have an opening into the drive bore long enough for long shank portions so that a user may use the same tool for both the short fasteners and the long fasteners. However, a long drive bore opening provides an exit that allows short shank portions of short fasteners to tip or angle into the opening as short fasteners are driven, also known as 'diving back' or 'tumbling' into the magazine. Diving back may cause inaccurate driving of the fastener, jamming of the tool, or damage to the tool due to the large forces needed to drive the fasteners into the substrate. These problems are exacerbated when combustion-powered tools are used to drive fasteners into concrete or steel.

[3] What is needed are collations that accommodate fasteners of various lengths while overcoming the problems of the prior art.

BRIEF SUMMARY OF THE INVENTION

[4] A collation for transporting a plurality of fasteners along rails disposed within a magazine of a fastener driving tool is provided having a plurality of sleeves for supporting and carrying the plurality of fasteners through the magazine, each of the plurality of sleeves having a front and a predetermined length of between about ¼ and about 0.4 inch, each of the plurality of fasteners having a predetermined fastener length of between about ¾ inch and about 1 ½ inch and a tip located at a predetermined position from about 0.05 inch behind front of sleeve to about ½ inch beyond the front of sleeve. A plurality of frangible bridges integrally connect the sleeves together in a serial array and facilitate the separation of a leading one of the plurality of sleeves from remaining ones of the plurality of serially arranged sleeves when a drive member of the fastener driving tool drives a leading one of the plurality of fasteners disposed within the leading one of the plurality of sleeves. Each sleeve includes a plurality of protrusions for engaging rails in the magazine.

[5] A system of collations for supplying fasteners of at least two different lengths to a fastener driving tool is provided. A plurality of first collations each have a plurality of sleeves each having a front, wherein the sleeves hold first fasteners having a tip located at a predetermined position relative to said sleeve front, and a plurality of second collations each have a plurality of second sleeves each having a front, wherein the second sleeves hold second fasteners having a tip located at the same predetermined position relative to the front of second sleeve, wherein the second fasteners are of a different length than the first fasteners.

[6] These and other features and advantages are evident from the following description of the present invention, with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[7] FIG. 1 is a partial side sectional view of a fastener driving tool with a nosepiece in an extended position.

[8] FIG. 2 is a partial side sectional view of the fastener driving tool with the nosepiece in a retracted position, wherein the nosepiece is pushed against a work surface.

[9] FIG. 3 is a sectional view of a loading opening into a drive bore of the fastener driving tool, taken along line 3-3 in FIG. 1.

[10] FIG. 4 is a sectional view of a first guidance zone of a magazine of the fastener driving tool, taken along line 4-4 in FIG. 1.

[11] FIG. 5 is a sectional view of a second guidance zone of the magazine, taken along line 5-5 in FIG. 1.

[12] FIG. 6 is a close side sectional view of the nosepiece, a fastener guide and a shear block of the fastener driving tool, wherein the nosepiece is in the extended position.

[13] FIG. 7 is a close side sectional view of the nosepiece, the fastener guide, and the shear block, wherein the nosepiece is in the retracted position.

[14] FIG. 8A is a side view of a first collation of the present invention, wherein the first collation holds short fasteners.

[15] FIG. 8B is a side view of a second collation that holds medium fasteners.

[16] FIG. 8C is a side view of a third collation that holds long fasteners.

[17] FIG. 9 is an elevation view of collations, taken along line 9-9 in FIG. 8C.

[18] FIG. 10 is a sectional view of a sleeve of the collation, taken along line 10-10 in FIG. 9.

[19] FIG. 11 is a sectional view of a sleeve taken along line 11-11 in FIG. 9.

DETAILED DESCRIPTION OF THE INVENTION

[20] Referring to FIGS. 1 and 2, a fastener driving tool 10 is shown having a guidance system that accommodates fasteners 12a, 12b, 12c of various lengths FL in collations 64a, 64b, 64c (see FIGS. 8A-8C) for driving fasteners 12a, 12b, 12c into a substrate 2.

Tool 10 includes a tool body 20 having a front end 22, a rear end 24, and a cylinder 26 with an axis 28, a piston 30 mounted within cylinder 26, a power source, such as a combustion chamber 34 for combusting fuel, for driving piston 30 axially forwardly, a driver blade 32 extending axially forwardly from piston 30, a nosepiece 36 extending axially forwardly from front end 22 of tool body 20, wherein nosepiece 36 encloses a drive bore 38 for guiding fasteners 12a, 12b, 12c and driver blade 32 toward work surface 6, there being a loading opening 40 into drive bore 38 for fasteners 12a, 12b, 12c, and a magazine 42 for guiding fasteners 12a, 12b, 12c to loading opening 40. In one aspect of the invention, magazine 42 and nosepiece 36 are fixed with respect to each other, and tool 10 further includes a fastener guide 44 extending axially forwardly from nosepiece 36, wherein fastener guide 44 is movable with respect to nosepiece 36 between an extended position (FIG. 1) and a retracted position (FIG. 2).

[21] Turning to FIG. 3, in another aspect, loading opening 40 into drive bore 38 has a main channel 120 and a tip channel 124 protruding a predetermined channel depth TCD from main channel 120, wherein the predetermined tip channel depth TCD is slightly larger than a predetermined exposed tip length TL between tip 18a, 18b, 18c of fastener 12a, 12b, 12c and a front end 74 of a corresponding collation sleeve 58 that is holding fastener 12a, 12b, 12c, so that there is a small clearance through which tips 18a, 18b, 18c can pass, wherein main channel 120 is long enough to accommodate fasteners 12a, 12b, 12c of at least two different lengths FL.

[22] As shown in FIGS. 8A-8C, collation 64a, 64b, 64c is provided for transporting fasteners 12a, 12b, 12c along rails 86 disposed within magazine 42. Collation 64a, 64b, 64c includes a plurality of sleeves 58 for supporting and carrying fasteners 12a, 12b, 12c through magazine 42. Each sleeve 58 has a length of between about ¼ inch and about 0.4 inch, and each fastener 12a, 12b, 12c has a predetermined exposed tip length TL from said sleeve 58 of between about 1/8 inch and about ¼ inch. A plurality of frangible bridges 96, 97 are also provided integrally connecting sleeves 58 together in a serial array, and facilitating separation of a leading sleeve 58 from the remaining sleeves 58 when driver blade 32 drives a leading fastener 12a, 12b, 12c held within the leading sleeve 58. Fasteners 12a, 12b, 12c having various lengths FL, as shown in FIGS. 8A-8C, may be used by tool 10, wherein different length FL fasteners are used for different applications. In one embodiment, fasteners having a length FL of between about ¾ inch and about 1 inch are used in collations 64a, 64b, 64c.

[23] Tool 10 drives fasteners 12a, 12b, 12c for fastening a work piece 4 to a substrate 2. Preferably, tool 10 is designed for fastening work piece 4 to a hard substrate 2, such as concrete or steel used in commercial construction. Work piece 4 may be thin, such as thin sheet steel, or work piece 4 may be relatively thick, such as plywood. In one embodiment, tool 10 is used to drive fasteners 12a, 12b, 12c to anchor metal tracking,

see FIG. 2, to concrete floors, ceilings or walls, wherein studs are attached to the tracking in order to mount drywall to the studs to build walls.

1 TOOL OVERVIEW

[24] Returning to FIGS. 1 and 2, tool 10 includes a body 20 having a front end 22 and a rear end 24, with a handle 46 depending from body 20 for a user to hold tool 10. A trigger 48 is mounted to handle 46 for actuating tool 10. Tool 20 encloses a cylinder 26 having an axis 28, wherein a reciprocating piston 30 is mounted within cylinder 26 so that piston 30 is coaxial with cylinder 26 and so that piston 30 slides within cylinder 26. Piston 30 is driven axially forwardly toward front end 22 by a pressurized gas to the rear of piston 30. A power source is included to provide the pressurized gas to drive piston 30 axially forwardly in the driving direction. The power source may provide pressurized gas pneumatically using pressurized air fed to a pneumatic cylinder (not shown), by combustion of fuel in a combustion chamber 34, or by exploding powder in a powder actuated tool. Because tool 10 is preferably designed for driving fasteners 12a, 12b, 12c into a hard substrate, such as concrete or steel, in one embodiment, shown in FIGS. 1 and 2, the power source is a combustion chamber 34 for combusting fuel to provide the large force needed to drive fasteners 12a, 12b, 12c into concrete or steel.

[25] Tool 10 may also include a combustion chamber sleeve 50 mounted in tool body 20 in a sliding manner so that sleeve 50 is movable between an open position (FIG. 1) and a closed position (FIG. 2). When sleeve 50 is in the open position, combustion chamber 34 is also open and tool 10 cannot be fired. When sleeve 50 is moved into the closed position, it closes combustion chamber 34, so that when tool 10 is fired, the pressurized gas acts to drive piston 30 in the driving direction. Combustion chamber sleeve 50 is operatively connected to fastener guide 44 of tool 10 (described below), so that when fastener guide 44 is pushed against a work surface 6, it pushes sleeve 50 into the closed position, which closes combustion chamber 34, allowing tool 10 to be fired only when fastener guide 44 is pushed against work surface 6.

[26] Continuing with FIGS. 1 and 2, driver blade 32 extends forwardly from piston 30 so that driver blade 32 is driven forwardly along with piston 30. In one embodiment, driver blade 32 is a separate piece that is mounted to piston 30, allowing driver blade 32 to be manufactured separately from piston 30. Driver blade 32 has a leading end 52 that strikes fastener head 16a, 16b, 16c to drive fastener 12a, 12b, 12c toward a work surface 6 on work piece 4. Preferably, driver blade 32 is generally cylindrical so that it corresponds to fastener head 16a, 16b, 16c and drive bore 38.

[27] A resilient buffer 54 is located at leading end 56 of cylinder 26 to protect piston 30 and cylinder 26 from damage by absorbing shock from piston 30. Buffer 54 may be made from a resilient plastic, and preferably is made from urethane or rubber.

[28] Turning to FIGS. 1, 2, 6, and 7, a nosepiece 36 extends forwardly from front end 22 of tool body 20, wherein nosepiece 36 encloses drive bore 38 to guide fasteners 12a, 12b, 12c and driver blade 32 toward work surface 6. Loading opening 40 preferably has a geometry that permits fastener 12a, 12b, 12c and its corresponding sleeve 58 to pass through loading opening 40 and into drive bore 38 only when fastener 12a, 12b, 12c and sleeve 58 are oriented properly. Preferably, loading opening 40 also has a geometry that eliminates the exit for short fasteners in order to prevent their tips from diving back out of drive bore 38.

[29] In one embodiment, nosepiece 36 includes an axially extending generally semi-circular groove which makes up part of drive bore 38. A shear block 60 is mounted to nosepiece 36, wherein shear block 60 also includes an axially extending generally semi-circular groove that corresponds to and is registered with the semi-circular groove of nosepiece 36 so that the semi-circular grooves form drive bore 38 so that both nosepiece 36 and shear block 60 guide fasteners 12a, 12b, 12c and driver blade 32 toward work piece 4 and substrate 2. Preferably, shear block 60 is removable, allowing a user to perform maintenance on tool 10, such as clearing out jams in drive bore 38. Preferably, shear block 60 includes loading opening 40 so that shear block 60 guides fasteners 12a, 12b, 12c into drive bore 38.

2 COLLATIONS

[30] Turning to FIGS. 8A-8C and 9, different collations 64a, 64b, 64c may be provided for different applications. For example, a first collation 64a holds short fasteners 12a, which are used for one application, wherein each fastener 12a has a tip 18a that is located at a predetermined position relative to front end 74 of sleeve 58. A second collation 64b holds medium fasteners 12b which may be used for another application, wherein each fastener 12b has a tip 18b that is located at the same predetermined position relative to front end 74. Similarly, a third collation 64c holds long fasteners 12c, which may be used for yet another application, wherein each fastener 12c has a tip 18c that is located at the same predetermined position relative to front end 74. Preferably, each fastener tip 18a, 18b, 18c protrudes beyond front end 74 so that each fastener 12a, 12b, 12c has a predetermined tip length TL.

[31] Each collation 64a, 64b, 64c includes a carrier 65 fabricated from a suitable polymeric material. In one embodiment, carrier 65 is molded from a plastic, and preferably from polypropylene. Carrier 65 comprises a plurality of sleeves 58 arranged substantially in a linear row, wherein each sleeve 58 includes a rear end 72 and a front end 74, with a bore 76 extending between rear end 72 and front end 74 for receiving a corresponding fastener 12a, 12b, 12c. Collation 64a, 64b, 64c is manufactured by first molding carrier 65 of sleeves 58, which are connected together in a row, followed by inserting fasteners 12a, 12b, 12c into sleeves 58 to create collation 64a, 64b, 64c.

Adjacent sleeves 58 of collation 64a, 64b, 64c are integrally connected together by at least one bridge 96, 67, and in one embodiment, adjacent sleeves 58 are connected together by an upper bridge 96 and a lower bridge 97.

[32] Preferably, carrier 65 is substantially symmetrical about both a horizontally oriented axis and a vertically oriented axis so that carrier 65 may be properly used within magazine 42 of a fastener driving tool 10 regardless of whether or not the carrier 65 is effectively rotated 180° around either axis so that what was formerly the upper end of a sleeve is now the lower end, and what was formerly the leading sleeve is now the trailing sleeve. Also, symmetrical objects are easier to mold, and hence simplify the process of manufacturing carrier 65. However, carrier 65 can also be unsymmetrical if desired. Collation 64a, 64b, 64c may have between about five and about fifty sleeves 58 arranged in a linear row, preferably between about ten and about twenty sleeves 58, still more preferably about fifteen sleeves 58.

2.1 FASTENERS

[33] Continuing with FIGS. 8A-8C, preferably, fasteners 12a, 12b, 12c are used to fasten a work piece 4, such as the metal track shown in FIG. 2, to a hard substrate 2, such as concrete or steel used in commercial construction. Each fastener 12a, 12b, 12c has an elongate shank 14a, 14b, 14c with a head 16a, 16b, 16c at one end and a tip 18a, 18b, 18c at the opposite end. Fastener 12a, 12b, 12c includes an ogive 19a, 19b, 19c that tapers from the end of shank 14a, 14b, 14c to tip 18a, 18b, 18c, wherein ogive 19a, 19b, 19c is generally conical in shape. Fasteners 12a, 12b, 12c are drive pins made from metal that provide sufficient tensile strength, toughness, and durability to be driven through work piece 4 and into a hard substrate 2, which may be concrete or steel, without bending or breaking. In one embodiment, fasteners 12a, 12b, 12c are made from a heat treated high carbon steel alloy, preferably from an AISI 1060-1065 steel alloy that is heat treated with an austemper process to a core hardness of between about 52 and about 56 Rockwell C hardness. Fasteners 12a, 12b, 12c may also be made from stainless steel alloys for corrosion resistance, or other metals or metal alloys.

[34] Fasteners 12a, 12b, 12c which are used for driving into concrete or steel preferably have a shank diameter of between about 1/16 inch and about 3/16 inch, preferably between about 0.1 inch and about 0.15 inch, still more preferably about 1/8 inch and a head diameter of between about 1/8 inch and about 3/8 inch, preferably between about 0.2 inch and about 0.3 inch, still more preferably about ¼ inch.

[35] The length FL of fasteners 12a, 12b, 12c depends on the desired application. For example, short fasteners 12a, shown in FIG. 8A, having a length FL (measured between tip 18a and the bottom of head 16a) of between about ¼ inch and about 5/8 inch, preferably between about 3/8 and about 9/16, still more preferably about ½ inch, are used to attach thin metal work pieces 4, such as the metal track shown in FIG. 2, to

a hard substrate 2, such as concrete or steel. Short fastener 12a is preferred for this type of application because relatively short fasteners have a relatively high column strength in their shanks, which allows short fastener 12a to withstand the high force needed to drive fastener 12a though metal work piece 4 and into the hard substrate 2. Short fastener 12a may also be used if an application does not require a higher holding strength that may be provided by longer fasteners.

[36] Longer fasteners, such as medium fasteners 12b, shown in FIG. 8B, having a length FL of between about 5/8 inch and about 7/8 inch, preferably between about 11/16 inch and about 13/16 inch, still more preferably about ¾ inch, or long fasteners 12c, shown in FIG. 8C, having a length FL between about 7/8 inch and about 2 inches, preferably between about 15/16 inch and about 1 ½ inch, still more preferably about 1 inch, have smaller column strengths than short fastener 12a, so that longer fasteners 12b, 12c may not be ideal for fastening a thin metal work piece 4 to hard concrete or steel because shank 14b, 14c is more likely to bend or break. Also, tool 10 may need more driving power to drive longer fasteners 12b, 12c into a hard substrate 2, particular a thick substrate 2 such as concrete, but longer fasteners 12b, 12c may provide more holding strength once they are installed. However, thicker work pieces, such as plywood (not shown), may accommodate longer fasteners 12b, 12c because the thicker work piece acts to brace longer shanks 14b, 14c to compensate for their smaller column strength. Also, longer shanks 14b, 14c are needed to extend through thicker work pieces and into the substrate, so that the work piece and substrate and fastened together.

[37] In one system for use with concrete or steel substrates 2, three sets of collations 64a, 64b, 64c carrying fasteners 12a, 12b, 12c are provided having nominal lengths of ½ inch (short fasteners 12a), ¾ inch (medium fasteners 12b), and 1 inch (long fasteners 12c), so that a user may select which fasteners 12a, 12b, 12c are appropriate for a given application.

2.1.1 POSITION OF TIP

[38] Continuing with FIGS. 8A-8C, in one embodiment, each fasteners 12a, 12b, 12c has a tip 18a, 18b, 18c that is located at a predetermined position relative to front end 74 of sleeve, preferably so that there is a small exposed tip length TL, which may include part of all of ogive 19a, 19b, 19c and tip 18a, 18b, 18c, and also may include part of shank 14a, 14b, 14c. Preferably, the position of tip 18a, 18b, 18c is substantially uniform regardless of what length FL of fastener 12a, 12b, 12c is used. As shown in FIGS. 8A-8C, exposed tip length TL of short fastener 12a is the same as exposed tip length TL of medium fastener 12b, and the same exposed tip length TL of long fasteners 12c.

[39] Also, preferably, the predetermined exposed tip length TL between front sleeve end

74 and corresponding fastener tip 18a, 18b, 18c is as small as possible without affecting the alignment of fastener 12a, 12b, 12c within sleeve 58 so that sleeve 58 provides guidance to tip 18a, 18b, 18c as fastener 12a, 12b, 12c is driven toward work surface 6 so that the likelihood that fastener tip 18a, 18b, 18c will begin to dive back toward magazine 42 is reduced. The close spacing of front sleeve end 74 and fastener tip 18a, 18b, 18c helps prevent fasteners 12a, 12b, 12c from diving back into magazine 42 because it allows tool 10 to be configured to remove the exit path that may allow fastener tip 18a, 18b, 18c to exit drive bore 38 through loading opening 40, described below. Also, because of the small predetermined exposed tip length TL, sleeves 58 provide guidance to tips 18a, 18b, 18c as fastener 12a, 12b, 12c is driven toward work surface 6 so that the likelihood that fastener tip 18a, 18b, 18c will begin to dive back toward magazine is reduced. In addition, sleeve 58 aligns tip 18b, 18c of longer fasteners 12b, 12c with axis 28 so that tips 18b, 18c remain centered in bore when the leading sleeve 58 is sheared from the second sleeve 58, and tip 18b, 18c is captured by fastener guide 44.

[40] The predetermined position of tip 18a, 18b, 18c relative to front sleeve end 74 is selected so that tip 18a, 18b, 18c is positioned in a zone relative to front sleeve end 74 between fastener tip 18a, 18b, 18c being slightly recessed within bore 76, i.e. about 0.05 inch behind front end 74 and a position that protrudes from sleeve 58 so that an exposed tip length TL is formed. Fastener tip 18a, 18b, 18c may be flush with front end 74 or recessed within sleeve bore 76, however, it may be difficult to ensure the alignment of fastener 12a, 12b, 12c and the support of fastener shank 14a, 14b, 14c if tip 18a, 18b, 18c is recessed within bore 76, therefore, for practical reasons, in one embodiment front sleeve end 74 is positioned within this zone so that tip 18a, 18b, 18c has an exposed tip length TL below front sleeve end 74. In one embodiment, the pre-determined position of tip 18a, 18b, 18c is located between about 0.1 inch behind front end 74 of sleeve 58 and about ½ inch beyond front end 74, preferably between about 0.05 inch behind front end 74 and about ¼ inch beyond front end 74, and still more preferably so that tip 18a, 18b, 18c has an exposed tip length TL of about 0.2 inch.

[41] In one embodiment, collations 64a, 64b, 64c are manufactured by inserting fasteners 12a, 12b, 12c through sleeve bores 76, and fastener tips 18a, 18b, 18c may be placed within a manufacturing tolerance of about 0.025 inch from the desired exposed tip length TL. For example, if the desired exposed tip length TL is about 0.205 inch, then during manufacturing of collations 64a, 64b, 64c, fastener tips 18a, 18b, 18c should be placed between about 0.18 inch and about 0.23 inch from front sleeve ends 74.

2.1.2 EXPOSED NECK LENGTH

[42] Continuing with FIGS. 8A-8C, because the exposed tip length TL of fasteners 12a,

12b, 12c may be uniform regardless of the length FL of fastener 12a, 12b, 12c that is used, the length NL of an exposed neck 17a, 17b, 17c of fasteners 12a, 12b, 12c will vary depending on the length FL of fastener being used. For example, for short fasteners 12a having a length FL of between about ¼ inch and about ¾ inch, neck 17a has a length NL of between about 0 inch, wherein head 16a is abutted against rear end 72, and about 0.05 inch, preferably between about 0.001 inch and about 0.02 inch, still more preferably about 0.005. For longer fasteners, such as medium fasteners 12b or long fasteners 12c, the exposed neck length NL is preferably between about 0.2 inch and about 1 ½ inch. In one embodiment, for medium fasteners 12b having a length FL of about ¾ inch, neck 17b has a length NL of between about 0.1 inch and about 3/8 inch, preferably between about 0.2 inch and about ¼ inch, still more preferably about 0.22 inch, and for long fastener 12c having a length FL of about 1 inch, neck 17c has a length NL of between about 3/8 inch and about ¾ inch, preferably between about 0.4 inch and about 5/8 inch, still more preferably about 0.47 inch.

[43] Also, for longer fasteners 12b, 12c, it is preferred that the exposed neck length NL be approximately at least as long as exposed tip length TL, and for long fasteners 12c, approximately at least twice as large as exposed tip length TL.

2.2 SLEEVES

[44] Continuing with FIGS. 1 and 8A-8C, fasteners 12a, 12b, 12c are collated in a row by collation 64a, 64b, 64c which includes a plurality of collation sleeves 58 connected together in series, wherein each sleeve 58 holds and supports a fastener 12a, 12b, 12c. Collation 64a, 64b, 64c provides a plurality of fasteners 12a, 12b, 12c connected together as a single unit, which is easier for a user of tool 10 to manipulate. Collation 64a, 64b, 64c also provides proper spacing between adjacent fasteners 12a, 12b, 12c to ensure that tool 10 only drives one fastener 12a, 12b, 12c at a time. The width across sleeve 58 is preferably about the same as the diameter of fastener heads 16a, 16b, 16c so that both sleeve 58 and fastener head 16a, 16b, 16c help guide fastener 12a, 12b, 12c as it is driven through drive bore 38. Each sleeve may have a width of between about 1/8 inch and about 3/8 inch, preferably between about 0.2 inch and about 0.3 inch, still more preferably about 0.27 inch.

[45] Collation 64a, 64b, 64c sequentially feeds fasteners 12a, 12b, 12c through loading opening 40 into drive bore 38 via a magazine 42 so that a leading fastener 12a, 12b, 12c is positioned within drive bore 38 to be driven by driver blade 32. As the leading fastener 12a, 12b, 12c is driven through drive bore 38 by driver blade 32, its corresponding leading sleeve 58 is sheared from a second adjacent sleeve 58. The leading fastener 12a, 12b, 12c and sleeve 58 are driven through drive bore 38 toward work surface 6 on work piece 4. As fastener 12a, 12b, 12c is driven into work piece 4 and substrate 2, sleeve 58 is split apart so that it separates from fastener 12a, 12b, 12c or

sleeve 58 becomes trapped under fastener head 16a, 16b, 16c. In one embodiment, each sleeve 58 includes a pair of generally V-shaped notches 73 at rear sleeve end 72 and a pair of generally V-shaped notches 75 at front sleeve end 74 so that fastener 12a, 12b, 12c will readily split sleeve 58 as fastener head 16a, 16b, 16c is driven through sleeve 58. After the leading fastener 12a, 12b, 12c has been driven, the spring force of a spring biased follower (not shown) in magazine 42 pushes the second fastener 12a, 12b, 12c into drive bore 38 so that the second fastener 12a, 12b, 12c becomes the leading fastener, and a third fastener becomes the second fastener.

[46] Continuing with FIGS. 8A-8C, adjacent sleeves 58 of collation 64a, 64b, 64c are connected with one or more frangible bridges 96. Bridges 96 are designed to be sheared when the leading fastener 12a, 12b, 12c held within the leading sleeve 58a is driven by driver blade 32 so that the leading sleeve 58 is sheared from the second sleeve 58 along a breaking plane 98 located at the juncture between bridges 96 of the leading sleeve 58 and adjacent bridges 96 of the second sleeve 58. Bridges 96, 97 may be dimensioned to maximize fastener density while avoiding jamming and improving guidance, e.g., the distance between sleeves 58 may be between about 3% and about 20%, preferably between about 5% and about 12% of the in-line thickness of sleeve 58.

[47] Each sleeve 58 ensures that corresponding fastener 12a, 12b, 12c is coaxially aligned within drive bore 38 of tool 10, so that fasteners 12a, 12b, 12c are driven substantially perpendicularly with respect to work surface 6, otherwise fastener 12a, 12b, 12c may bend or be driven crooked, preventing proper fastening of work piece 4 to substrate 2, or fastener 12a, 12b, 12c may ricochet off of the substrate 2 due to the hardness of substrate 2 and the force in which fastener 12a, 12b, 12c is driven .

[48] Each fastener 12a, 12b, 12c is inserted through a corresponding sleeve 58 of carrier 65 so that fastener 12a, 12b, 12c has a predetermined exposed tip length TL from front end 74 of the corresponding sleeve 58, and head 16a, 16b, 16c is spaced a predetermined distance NL from rear end 72 of the corresponding sleeve 58. Each sleeve 58 has a predetermined axial length that is long enough to properly align and support fastener 12a, 12b, 12c, yet not so long as to be overly expensive. In one embodiment, the predetermined axial length of each sleeve 58 is between about 1/8 inch and about ½ inch, preferably between about ¼ inch and about 0.4 inch, still more preferably about 0.32 inch. In one embodiment, each sleeve 58 includes a plurality of protrusions, such as collars 78, 80, integrally provided upon sleeve 58 for engaging rails 86 within magazine 42.

[49] Sleeves 58 may be formed into one of many geometric shapes, including cylindrical, but in one embodiment, shown in FIG. 9, each sleeve 58 has a substantially square-shaped cross section and sleeve bore 76 also has a substantially square-shaped

cross section with interior side walls 77, while fastener shanks 14a, 14b, 14c have a substantially circular cross section. A portion of each fastener shank 14a, 14b, 14c will engage a corresponding interior side wall 77 of a corresponding sleeve 58 at a substantially central portion of interior side wall 77 and along a substantially vertically oriented locus along interior side wall 77 (shown as long fastener shank 14c in FIG. 9). In one embodiment, each interior side wall 77 includes one or more crush ribs or dimples 79, best shown in FIGS. 9 and 10, to accommodate fastener shanks 14a, 14b, 14c, which have a predetermined diameter within machined tolerances. Sleeves 58 may be dimensioned to maximize fastener density while avoiding jamming and improving guidance, e.g., each sleeve 58 may have an in-line thickness and a transverse thickness that is approximately equal to, e.g. between about 95% and about 110%, of the diameter of fastener heads 16a, 16b, 16c with close spaces provided by bridges 96, 97.

[50] Continuing with FIGS. 10 and 11, in one embodiment, each sleeve 58 includes an upper collar 78 at rear end 72 and a lower collar 80 at front end 74 wherein upper and lower collars 78, 80 protrude laterally outwardly from sleeve 58 so that there is a pair of lateral channels 92 on each side of sleeve 58 between upper collar 78 and lower collar 80. Rails 86 of magazine 42 are received by channels 92 so that rails 86 engage collars 78, 80 and guide collation 64a, 64b, 64c through magazine 42. In one embodiment, a window 94 is included in each channel 92 through which a portion of fastener shank 14a, 14b, 14c emerges. Fasteners 12a, 12b, 12c can also be held tog ether by separate upper and lower collars (not shown), i.e. by a plurality of joined upper collars proximate fastener heads 16a, 16b, 16c and a plurality of separate joined lower collars proximate fastener tips 18a, 18b, 18c.

[51] Preferably, upper and lower collars 78, 80 each include a rail engaging member or projection 82, 84 for engaging rails 86 of magazine 42. In one embodiment, projections 82, 84 protrude toward each other into channels 92. A pair of upper projections 82 protrudes downwardly from upper collar 78, while a pair of lower projections 84 protrudes upwardly from lower collar 80, so that upper projections 82 protrude toward lower projections 84, and lower projections 84 protrude toward upper projections 82. Each upper projections 82 is generally vertically aligned with a corresponding lower projection 84, and conversely each lower projections 84 is generally vertically aligned with a corresponding upper projection 82, so that a space is defined between upper projections 82 and lower projections 84 within which rails 86 of magazine 42 may be accommodated.

[52] In one embodiment, each projection 82, 84 has a substantially pyramidal configuration so that each projection 82, 84 includes a contact tip region 83, 85 for engaging a surface portion of one of magazine rails 86. Preferably, each contact tip

region 83, 85 comprises a substantially point-type radiused contact region for engaging rail 86 of magazine 42 so that the frictional forces generated between collation 64a, 64b, 64c and rails 86 are effectively reduced as much as possible so that the conveyance of collation 64a, 64b, 64c through magazine 42 is as smooth as possible to avoid hang-ups.

3 MAGAZINE

[53] Turning to FIGS. 1, 4 and 5, a magazine 42 is provided to feed fasteners 12a, 12b, 12c to loading opening 40 so that fasteners 12a, 12b, 12c are fed into drive bore 38, where fasteners 12a, 12b, 12c are driven by driver blade 32. Magazine 42 feeds fasteners 12a, 12b, 12c so that they are aligned properly with loading opening 40 and with drive bore 38. Magazine 42 includes a housing 62 configured to receive a collation 64a, 64b, 64c of collated fasteners 12a, 12b, 12c, described below. In one embodiment, magazine housing 62 is mounted to handle 46 and includes a feed end 66 with a slot-like opening through which collations 64a, 64b, 64c are inserted, an exit end 68 having an exit opening which is in alignment or registry with loading opening 40 to allow free and sequential passage of fasteners 12a, 12b, 12c and sleeves 58 through the exit opening and loading opening 40, and into drive bore 38. A spring biased follower (not shown) pushes collation 64a, 64b, 64c of fasteners through magazine 42 toward exit opening 70. Magazine 42 described herein is designed primary to address operational characteristics of fastener collation 64a, 64b, 64c, which is described below.

[54] Magazine 42 includes guidance means that extend between feed end 66 and exit end 68, which preferably is provided with at least two guidance formations, a first guidance formation 100 configured for engaging fastener collation 64a, 64b, 64c at a first location on collation 64a, 64b, 64c, and a second guidance formation 102 configured for engaging collation 64a, 64b, 64c at a second location on collation 64a, 64b, 64c.

[55] Magazine 42 facilitates loading of collations 64a, 64b, 64c so that they do not become caught or jammed in magazine 42, and guiding collation 64a, 64b, 64c to loading opening 40. In this way, magazine 42 defines a feed passageway 104 which extends the full length of magazine 42 from feed end 66 to exit end 68. A first guidance zone 106, which includes first guidance formation 100, begins at feed end 66 and is configured for engaging collation 64a, 64b, 64c at front sleeve ends 74.

3.1 FIRST GUIDANCE FORMATION

[56] As shown in FIG. 4, in one embodiment, first guidance formation 100 in magazine 42 includes a feed passageway 104 having a collation channel 116a for accommodating sleeves 58 and a head channel 116b spaced from collation channel 116a

for accommodating heads 16a, 16b, 16c of fasteners 12a, 12b, 12c having a particular fastener length FL. For example, lower head channel 116b, shown in FIG. 4, is positioned to accommodate head 16b of medium fastener 12b. Additional head channels may be included for heads of fasteners having other lengths, such as head channel 116c for heads 16c of long fasteners 12c.

[57] First guidance formation includes a pair of shoulders 110 that project laterally into feed passageway 104 to provide a track for front sleeve ends 74. Front sleeve ends 74 slidably ride on shoulders 110 while fastener tip 18a, 18b, 18c extends axially between shoulders 110 into a tip channel 112 of feed passageway 104. As described above, it may be desirable to have fastener tip 18a, 18b, 18c be flush with front end 74 or recessed within sleeve bore 76. In this case, a pair of shoulders may not be necessary, but instead a single guidance surface extending across the lower end of feed passageway 104 that supports front sleeve end 74 may be used. The alignment of collation 64a, 64b, 64c is maintained by the spacing between shoulders 110, which allows limited lateral movement of fasteners 12a, 12b, 12c, and hence limited lateral movement of collation 64a, 64b, 64c.

[58] In one embodiment, shown in FIG. 4, strip passageway 104 at first guidance formation 100 includes a collation channel 116a, a tip channel 112, a first head channel 116b and a second head channel 116c. The pair of shoulders 110 are at a forward end 117 of collation channel 116a and collation channel 116a extends rearwardly from forward end 117 far enough to accommodate sleeve 58. Tip channel 112 protrudes forwardly from forward end 117 of collation channel 116a. First head channel 116b is spaced rearwardly from collation channel 116a by a first rail 114a, wherein first head channel 116b accommodates head 16b of medium fastener 12b, but not head 16a of short fastener 12a or head 16c of long fastener 12c . Second head channel 116b is spaced rearwardly from first head channel 116a by a second rail 114b, wherein second head channel 116b accommodates head 16c of long fastener 12c, but not head 16a of short fastener 12a or head 16b of medium fastener 12b . In one embodiment, collation channel 116a is long enough to accommodate sleeve 58 and head 16a of short fastener 12a, but is not long enough to accommodate heads 16b, 16c of medium or long fasteners 12b, 12c. Channels 116a, 116b, 116c are each sized to accommodate a range of fastener lengths FL, and to allow for a manufacturing tolerance when placing fasteners 12a, 12b, 12c into sleeves 58. Head channels 116b, 116c are shorter than sleeve 58 so that a user cannot accidentally place sleeve 58 in either head channels 116b, 116c, which may cause collation 64a, 64b, 64c to be located in the wrong position when passing into second guidance zone 108 and loading opening 40, but rather only in collation channel 116a.

[59] Preferably, shoulders 110 extend toward feed end 66 of magazine 42 farther than

rails 114a, 114b, as shown in FIG. 1, so that a user may easily load collation 64a, 64b, 64c properly by placing fastener tip 18a, 18b, 18c into tip channel 112 and ensuring that front sleeve ends 74 are abutted against shoulders 110, and then sliding collation 64a, 64b, 64c along magazine 42 toward exit end 68 until fastener heads 16a, 16b, 16c are inserted into the appropriate channel 116a, 116b or 116c. In this way, shoulders 110 provide a frame of reference for the user as to where to place collation 64a, 64b, 64c.

3.2 SECOND GUIDANCE FORMATION

[60] Turning to FIG. 5, second guidance zone 108 in magazine 42 provides second guidance formation 102. In a preferred embodiment, second guidance formation includes a pair of rails 86 engaged with channels 92 of sleeves 58 so that projections 82, 84 engage rails 86. Second guidance zone 108 begins adjacent to first guidance zone 106 and extends substantially to exit end 68 of magazine 42 so that second guidance zone 108 accepts fasteners from first guidance zone 106, as shown in FIG. 1. Rails 86 extend laterally into strip passageway 104 so that the distance between rails 86 is smaller than the diameter of upper collars 78 and lower collars 80 so that rails 86 engage projections 82, 84. Rails 86 are spaced from each other to permit free slidability of collation 64a, 64b, 64c lengthwise along strip passageway 104, but only permitting slight lateral movement of collation 64a, 64b, 64c. Rails 86 have a thickness that is slightly smaller than the distance between upper projections 82 and lower projections 84 so that protrusions engage rails 86 along the length of magazine 42 to ensure that sleeves 58 and fasteners are properly aligned with loading opening 40. Because rails 86 are engaged between projections 82, 84, this alignment is maintained even when tool is used in an inverted position, so that collation 64a, 64b, 64c does not shift out of alignment in strip passageway 104. Projections 82, 84 engage rails 86 of magazine 42 so that along a portion of magazine 42 only sleeves 58 are in contact with rails 86. It has been found that when only a small portion of collation sleeves 58, such as projections 82, 84 described above, are in contact with rails 86 as collation 64a, 64b, 64c slides along magazine 42, there is less friction and collation 64a, 64b, 64c more easily slides along magazine 42, preventing collation 64a, 64b, 64c from becoming retarded, 'hung-up,' or jammed within magazine.

[61] In one embodiment, shown in FIG. 1, first guidance zone 106 overlaps with second guidance zone 108 to form a transition zone 118 where both shoulders 110 and rails 86 briefly engage collation 64a, 64b, 64c to ensure that collation 64a, 64b, 64c has a smooth transition from first guidance zone 106 to second guidance zone 108 so that sleeves 58 do not become hung up on rails 86. In this way, first guidance zone 106 and second guidance zone 108 act in cooperation to ensure that collations 64a, 64b, 64c of fasteners 12a, 12b, 12c are properly loaded into magazine 42 and to ensure that

collations 64a, 64b, 64c are properly aligned with loading opening 40.

4 LOADING OPENING

[62] Turning now to FIG. 3, as described above, preferably, tool 10 is designed to accommodate different collations 10a, 10b, 10c and fasteners 12a, 12b, 12c of different lengths FL for use in different applications. Therefore, preferably, fastener driving tool 10 is designed to accommodate the different fastener lengths FL associated with the fasteners of the different collations. For this purpose, magazine 42 and loading opening 40 must be axially long enough to accommodate the longest fasteners 12a, 12b, 12c that are to be driven by tool 10.

[63] Collations 64a, 64b, 64c may have a substantially uniform exposed tip length TL of fasteners 12a, 12b, 12c, regardless of the length FL of fastener 12a, 12b, 12c being used. Uniform exposed tip length TL only requires loading opening 40 to be long enough below sleeve 58 to allow fastener tips 18a, 18b, 18c to pass through loading opening 40. Therefore, loading opening 40 accommodates heads 16a, 16b, 16c of fasteners 12a, 12b, 12c having various lengths by being long enough above collation sleeves 58 to allow for fastener heads 16a, 16b, 16c located at different positions relative to sleeves 58. The length of the channel 124 of loading opening 40 that accommodates tip 18a, 18b, 18c only needs to be long enough to allow the uniform length of fastener tips 18a, 18b, 18c that extend below lower end of collation sleeve 58, which effectively eliminates the exit of short fastener tips 18a so that they may be prevented from diving back into magazine 42.

[64] Continuing with FIG. 3, loading opening 40 includes a main channel 120 for accommodating sleeves 58 and fastener heads 16a, 16b, 16c, and a tip channel 124 protruding forwardly from a forward end 122 of main channel 120 for accommodating fastener tips 18a, 18b, 18c. There is a pair of shoulders 126 at forward end 122 of main channel 120 for guiding front sleeve ends 74. Shoulders 126 support front end 74 of the second sleeve 58, shown in FIGS. 6 and 7, as the leading fastener 12a, 12b, 12c and the leading sleeve 58 are driven to ensure that there is a clean break between the leading sleeve 58 and the second sleeve 58. Shoulders 126 are substantially aligned with shoulders 110 of first guidance zone 106 in magazine 42.

4.1 TIP CHANNEL OF LOADING OPENING

[65] Continuing with FIG. 3, tip channel 124 protrudes from main channel 120 for a predetermined tip channel depth TCD from shoulders 126, wherein the predetermined tip channel depth TCD is slightly larger than the uniform exposed tip length TL so that there is a small clearance between a forward end 128 of tip channel 124 and fastener tips 18a, 18b, 18c, allowing fastener tips 18a, 18b, 18c to pass through tip channel 124. Tip channel 124 has a shape that substantially corresponds to the profile of ogive 19a,

19b, 19c. In one embodiment, fasteners 12a, 12b, 12c have generally conical ogives 19a, 19b, 19c, and tip channel 124 is generally parabolic, as shown in FIG. 3, however, tip channel 124 may have a pointed shape that substantially matches the conical shape of ogive 19a, 19b, 19c. Main channel 120 of loading opening 40 is long enough to accommodate the longest fasteners 12a, 12b, 12c that are intended to be driven by tool 10.

[66] Uniform exposed tip length TL of fasteners 12a, 12b, 12c, along with tip channel depth TCD of tip channel 124 of loading opening 40, allow tool 10 to discourage dive back of fasteners 12a, 12b, 12c into magazine 42 because fastener tips 18a, 18b, 18c do not have enough space or time to angle toward magazine 42 to pass back through loading opening 40. Even if fastener tip 18a, 18b, 18c starts to dive back toward magazine 42 , it is redirected by drive bore 38 toward work surface 6.

[67] In one embodiment, the depth TCD of tip channel 124 in loading opening 40 is larger than the uniform exposed tip length TL, but tip channel depth TCD should be as close to the uniform exposed tip length TL as possible to ensure that there is not enough space to form an exit for fastener tips 18a, 18b, 18c. In one embodiment, tip channel depth TCD is longer than the uniform exposed tip length TL by just enough to account for the expected manufacturing tolerance of the positioning of fastener tips 18a, 18b, 18c. In one embodiment, fasteners 12a, 12b, 12c may be inserted into sleeves 58 so that the exposed tip length TL is within about 0.025 inch of the desired uniform exposed tip length TL. For example, if the desired uniform exposed tip length TL is about 0.205 inch, than during manufacturing of collations 64a, 64b, 64c, fastener tips 18a, 18b, 18c should be placed between about 0.18 inch and about 0.23 inch from front sleeve ends 74. Therefore, in order to accommodate fasteners tips 18a, 18b, 18c in a collation 64a, 64b, 64c where the desired uniform exposed tip length TL is 0.205 inch, the predetermined channel depth TCD of tip channel 124 is preferably slightly larger than about 0.23 inch, e.g. about 0.235 inch, to ensure that tip channel 124 is longer than the longest expected exposed tip length TL while still having a close clearance between fastener tip 18a, 18b, 18c and forward end 128 of tip channel 124.

[68] The predetermined channel depth TCD of tip channel 124 is preferably between about 0 inch, i.e. so that tip channel 124 and main channel 120 are one and the same for the situation where fastener tips 18a, 18b, 18c are flush with front sleeve ends 74 or recessed within bore 76, and about 0.55 inch, more preferably between about 0.15 inch and about 0.275 inch, still more preferably about 0.235 inch. Because of the importance of the close clearance between fastener tips 18a, 18b, 18c and loading opening 40, it is important that the manufacturing tolerance of exposed tip length TL be tightly controlled because the smaller the manufacturing tolerance, the closer the clearance between fastener tip 18a, 18b, 18c and loading opening 40 is, the less likely

that fastener tips 18a, 18b, 18c will dive back through loading opening 40.

4.2 MAIN CHANNEL OF LOADING OPENING

[69] Continuing with FIG. 3, main channel 120 of loading opening 40 may have a generally rectangular shape so that sleeves 58 and fastener heads 16a, 16b, 16c fit through opening, however, preferably the shape of loading opening 40 is selected to correspond to the profile of collation 64a, 64b, 64c so that fasteners 12a, 12b, 12c and sleeves 58 sequentially fit through loading opening 40 only if they have the proper orientation. In one embodiment, main channel 120 of loading opening 40 is demarcated into a front channel 132 and a rear channel 134 by a pair of rails 130 that is axially spaced from shoulders 126, wherein rails 130 protrude into loading opening 40 for engaging the protrusions of sleeve 58, such as projections 82, 84, similar to how rails 86 in magazine 42 are engaged by projections 82, 84.

[70] Rails 130 are aligned with rails 86 so that as magazine 42 feeds fasteners 12a, 12b, 12c and sleeves 58 to loading opening 40, collation 64a, 64b, 64c remains properly positioned with respect to loading opening 40 so that collation 64a, 64b, 64c is not hung up and so that fastener tips 18a, 18b, 18c are positioned properly with respect to tip channel 124 of loading opening 40. In addition to engaging projections 82, 84, rails 130 may also protrude laterally inwardly far enough so that they engage fastener shank 14a, 14b, 14c within a close clearance in order to further axially align fastener 12a, 12b, 12c.

[71] As with shoulders 126 supporting front end 74 of second sleeve 58b, rails 130 support the second sleeve 58 by engaging and supporting projections 82, 84 so that the leading sleeve 58 is cleanly sheared as the leading fastener 12a, 12b, 12c is driven. Because rails 130 are engaged between projections 82, 84, they support the second sleeve 58 even when tool 10 is used in an inverted position.

[72] Like rails 86 of magazine 42, preferably rails 130 have a thickness that is approximately equal to the distance between projections 82, 84, within a small clearance, so that the second sleeve 58 is prevented from skewing upwardly or downwardly. In one embodiment, wherein the distance between upper projections 82 and lower projections 84 is about 0.097 inch, the thickness of rails 130 is about 0.091 inch, so that there is an average clearance of about 0.003 inch on either side between rails 130 and projections 82, 84.

[73] As shown in FIG. 3, main channel 120 of loading opening 40 may also include additional rails 136a, 136b that further demarcate main channel 120 into additional channels for receiving fastener head 16a, 16b, 16c. In one embodiment, main channel 120 further includes a pair of rails 136a spaced rearwardly from rails 130, there being a first head channel 137a rearwardly of rails 136a for accommodating the head 16b of medium fastener 12b, and a second head channel 137b spaced rearwardly from first

head channel 137a by another pair of rails 136b, wherein second head channel 137b accommodates the head 16c of long fastener 12c. In one embodiment, upper collar 78 and head 16a of short fastener 12a is accommodated between rails 130 and rails 136a. Preferably, rails 136a, 136b only engage fastener shank 14a, 14b, 14c, and not fastener head 16a, 16b, 16c, to prevent hang-ups of collation 64a, 64b, 64c through loading opening 40. However, rails 136a, 136b may be positioned to support fastener heads 16b, 16c if desired.

[74] As described above, preferably loading opening 40 is located though shear block 60. In one embodiment, shear block 60 has a thickness ST, so that shoulders 126, and rails 130, 136a, and 136b have a length through shear block 60 so that shoulders 126 and rails 130 support a substantial portion of second sleeve 58, and preferably all of second sleeve 58, still more preferably all of second sleeve 58 and a substantial portion of a third sleeve 58 (see FIGS. 6 and 7) so that the remainder of collation 64a, 64b, 64c that is not being driven is adequately supported so that when leading fastener 12a, 12b, 12c is driven, there is a clear break between leading sleeve 58 and second sleeve 58. Preferably, the side of loading opening 40 that faces into drive bore 38 is substantially aligned with breaking plane 98 between leading sleeve 58 and second sleeve 58 to further ensure a clean break. The thickness of shear block 60 also allows rails 130, 136a, and 136b to engage substantially all of shank 14a, 14b, 14c second fastener 12a, 12b, 12c, and preferably at least a portion of shank 14a, 14b, 14c of third fastener 12a, 12b, 12c. In one embodiment, shear block 60 has a predetermined thickness ST of between about ¼ inch and about ¾ inch, preferably between about 3/8 inch and about 5/8 inch, still more preferably about 0.59 inch, and shoulders 126 and rails 130, 136a, and 136b have a length that is substantially equal to the thickness ST of shear block 60.

5 FASTENER GUIDE

[75] Turning back to FIGS. 6 and 7, tool includes a telescoping fastener guide 44 for guiding fasteners 12a, 12b, 12c and sleeves 58 toward work piece 4 and substrate 2 as they are driven by driver blade 32. Fastener guide 44 receives the leading fastener 12a, 12b, 12c and sleeve 58 as they are driven from nosepiece 36 and shear block 60 and continues to guide leading fastener 12a, 12b, 12c and sleeve 58 toward work surface 6. Fastener guide 44 is coaxial with drive bore 38 so that as leading fastener 12a, 12b, 12c is driven axially forwardly, it will encounter and be guided by fastener guide 44. As described above, fasteners 12a, 12b, 12c are fed into drive bore 38 so that they are coaxially aligned with drive bore 38, so that fasteners 12a, 12b, 12c also are coaxially aligned with fastener guide 44.

[76] In one embodiment, fastener guide 44 is generally cylindrical in shape with a generally cylindrical bore 138 extending through fastener guide 44 between a rear end 140 and a front end 144. Fastener guide bore 138 includes a portion 142 at rear end

140 of fastener guide 44 that is tapered toward axis 28 to guide a driven fastener 12a, 12b, 12c toward bore 138 in the event that fastener tip 18a, 18b, 18c becomes angled away from axis 28 of tool. Bore 138 may also include a tapered portion 146 at front end 144 in order to provide space for portions of sleeve 58 that split away from fastener 12a, 12b, 12c as fastener 12a, 12b, 12c is driven into work piece 4 and substrate 2.

[77] Fastener guide 44 is movable between an extended position, shown in FIG. 6, and a retracted position, shown in FIG. 7, relative to nosepiece 36, shear block 60, and tool body 20, wherein fastener guide 44 is moved from the extended position to the retracted position when fastener guide 44 is abutted against work piece 4. When tool 10 is fired, a reactionary force is created in tool body 20 that causes tool body 20 to recoil away from work piece 4 and substrate 2. Nosepiece 36, shear block 60, and magazine 42 are operatively connected to tool body 20, so that when tool body recoils, so does nosepiece 36, shear block 60, and magazine 42. If fastener guide 44 were also to recoil along with nosepiece 36 and shear block 60, then nosepiece will lift off work piece 4 so that when fastener 12a, 12b, 12c exited fastener guide 44, it may be in free flight before it entered work piece 4 and substrate 2, which may cause fastener 12a, 12b, 12c to be driven at an undesired position, or misalignment of fastener 12a, 12b, 12c with respect to work piece 4, so that fastener may break, shear, or ricochet rather than drive cleanly through work piece 4 and substrate 2.

[78] For this reason, fastener guide 44 is configured so that it remains in abutment with work piece 4 when tool body 20 and nosepiece 36 recoil due to firing of tool 10. Fastener guide 44 is free to move independent of nosepiece 36 and shear block between the extended position and the retracted position, so that as nosepiece 36 recoils, fastener guide 44 is moved from the retracted position to the extended position. A spring (not shown) may also be included to bias fastener guide 44 toward the extended position to ensure that fastener guide 44 does not recoil as tool body recoils, but rather remains abutted against work piece 4.

[79] Because fastener guide 44 is separate from nosepiece 36 and shear block 60, and because fastener guide 44 moves independently of nosepiece 36 and shear block 60 as fastener guide 44 moves from the extended position to the retracted position, tool 10 has a loading opening 40 that is stationary with respect to magazine 42 so that there is a fixed loading position of fasteners 12a, 12b, 12c with respect to subsequent collations 64a, 64b, 64c. A fixed loading position with respect to magazine 42 allows a user to push fastener guide 44 against work surface 6 multiple times before firing without moving the leading fastener 12a, 12b, 12c and sleeve 58 up or down within drive bore 38, so that there is reduced risk of the second fastener 12a, 12b, 12c being loaded into drive bore 38 before the leading fastener 12a, 12b, 12c is driven.

[80] Continuing with FIGS. 1, 2, 6 and 7, fastener guide 44 is operatively connected to the power source so that the power source is activated when fastener guide 44 is placed in abutment with work surface 6 and moved into the retracted position. In one embodiment, fastener guide 44 is operatively connected to combustion chamber sleeve 50 via an actuator 148 and a link 150 so that when fastener guide 44 is in the extended position with respect to nosepiece 36, combustion chamber sleeve 50 is in the open position, and when fastener guide 44 is pushed against work surface 6 and moved into the retracted position, combustion chamber sleeve 50 is pushed into the closed position, so that combustion chamber 34 is activated when fastener guide 44 is pushed against work surface 6. As tool body 20 recoils due to the firing of tool 10, combustion chamber sleeve 50 remains operatively connected to fastener guide 44 so that combustion chamber sleeve 50 is moved from the closed position into the open position so that tool 10 will not be able to be fired again until fastener guide 44 is pushed into the retracted position again.

[81] Continuing with FIGS. 6 and 7, fastener guide 44 is preferably generally cylindrical in shape so that fastener guide 44 may be mounted with nosepiece 36 and shear block 60. In one embodiment, fastener guide 44 is mounted radially within a forward end 39 of drive bore 38, with forward end 144 of fastener guide 44 extending out of drive bore 38. In one embodiment, fastener guide 44 is also mounted within a generally cylindrical actuator 148, wherein forward end 144 of fastener guide 44 extends out of actuator 148 as well. Fastener guide 44 includes a radially outwardly protruding flange 152 that engages actuator 148 when fastener guide 44 is pushed into the retracted position so that flange 152 pushes actuator 148 rearwardly with respect to tool body 20. Actuator 148, in turn, is connected to a link 150, which is operatively connected to combustion chamber sleeve 50, so that as actuator 148 is pushed rearwardly by fastener guide 44, it pushes link 150 rearwardly, which pushes combustion chamber sleeve 50 rearwardly into the closed position, activating combustion chamber 34 allowing tool 10 to be fired.

[82] Fastener guide 44 may be slidably mounted to nosepiece 36 or shear block 60 so that fastener guide 44 does not fall out of engagement with tool 10. In one em bodiment, fastener guide 44 includes an axially extending groove 154 that extends for a predetermined distance along the outside surface 156 of fastener guide 44, wherein groove 154 accepts a key 158 of shear block 60 that is inserted into groove 154 when shear block 60 is mounted to nosepiece 36. When fastener guide 44 is in the extended position, key 158 is positioned so that it engages rear end 160 of groove 154, as shown in FIG. 6. When fastener guide 44 is moved to the retracted position, key 158 slides along groove 154 until key 158 is positioned at a front end 162 of groove 154 so that key engages front end 162, as shown in FIG. 7.

6 COLLATION AND TOOL SYSTEM

[83] A system for fastening a work piece 4 to a substrate 2 is provided, wherein the system includes a first collation 64a having a plurality of sleeves 58 holding fasteners 12a each having a predetermined exposed tip length TL, a second collation 64b having a plurality of sleeves 58 holding fasteners 12b each having substantially the same predetermined exposed tip length TL, wherein fasteners 12b are of different length FL than fasteners 12a. Fastener driving tool 10 includes a tool body 20 having a forward end 22, a rear end 24, and a cylinder 26 with an axis 28. A piston 30 is mounted within cylinder 26, and a power source, such as combustion chamber 34 for combusting fuel, is provided to drive piston 30 axially forwardly. A driver blade 32 extends axially forwardly from piston 30, and a nosepiece 36 extends axially forwardly from forward end 22 of tool body 20. Nosepiece 36 encloses a drive bore 38 for guiding fasteners 12a and driver blade 32 forwardly, wherein there is a loading opening 40 into drive bore 38, wherein loading opening 40 has a main channel 120 and a tip channel 124 having a depth TCD that is slightly larger than the exposed tip length TL so that there is a small clearance though which the tips 18a can pass.

[84] The system my further include a third collation 64c with sleeves 58 holding fasteners 12c, wherein fasteners 12b also have tips 18b with substantially the same predetermined exposed tip length TL as collations 64a and 64c so that the clearance of tip channel 124 is large enough for tips 18b also. Fasteners 12c of third collation 64c are of different length than fasteners 12a and 12b

[85] A system of collations 64a, 64b, 64c having fasteners 12a, 12b, 12c of different lengths FL, but with substantially the same exposed tip length TL, along with tool 10 having loading opening 40 with tip channel 124 having a depth that is slightly larger than the predetermined exposed tip length TL, allows a user of the system to have the tool and fasteners that are needed for various applications that are readily available. For example, a user may need short fasteners 12a (FIG. 8A) for attaching thin metal tracks 4 to hard substrates 2, such as concrete or steel, and longer fasteners, e.g., medium fasteners 12b (FIG. 8B), for attaching plywood work pieces to concrete or steel substrates, then the system of collations 64a of short fasteners 12a, collations 64b of medium fasteners 12b, and fastener driving tool 10 may be provided to the user, and the user may simply select the appropriate collation 64a, 64b having the appropriate length FL fastener 12a, 12b for whichever application the user is currently working on. The system may include collations 64c of long fasteners 12c (see FIG. 8C), which may be used by the user for thicker work pieces, or additional holding strength.

7 METHOD OF SELECTING AND DRIVING FASTENER

[86] A method of selecting and driving a fastener 12a, 12b, 12c for a particular ap-

plication is provided comprising the steps of providing a first collation 64a of a plurality of sleeves 58 holding first fasteners, such as short fasteners 12a each having a tip 18a with a predetermined exposed tip length TL below front sleeve end 74, providing a second collation 64c of a plurality of sleeves 58 each holding a corresponding second fastener, such as long fasteners 12c each having a tip 18c with substantially the same predetermined exposed tip length TL below front end 74, wherein fasteners 12c are longer than fasteners 12a, wherein short fasteners 12a and long fasteners 12c are adapted to be serially and individually driven through drive bore 38 of fastener driving tool 10 by a drive member, such as driver blade 32, so as to be discharged from tool 10, there being a loading opening 40 into drive bore 38 having a main channel 120 and a tip channel 124 providing a small clearance through which tips 18a or tips 18c can pass, the main channel 120 of loading opening 40 being long enough to accommodate short fasteners 12a and long fasteners 12c, selecting one of first collation 64a or second collation 64c for the desired length FL of fastener 12a, 12c for a particular application (i.e. short fastener 12a for a thin work piece 4, long fastener 12c for a thick plywood work piece), feeding the fasteners 12a, 12c of the selected collation 64a, 64c through loading opening 40, and driving the fasteners 12a, 12c of the selected collation 64a, 64c with driver blade 32.

[87] The method also may include the step of providing a third collation 64b of a plurality of sleeves 58 each holding a third fastener, such as medium fastener 12b having a tip 18b with substantially the same predetermined exposed tip length TL below front end 74, wherein fastener 12b is longer than short fasteners 12a, but shorter than long fasteners 12c. This method also includes the step of selecting any one of the first collation 64a of short fasteners 12a, the second collation 64b of medium fasteners 12b, or the third collation 64c of long fasteners 12c, and feeding the fasteners 12a, 12b, 12c of the selected collation 64a, 64b, 64c to drive bore 38.

[88] In one aspect, the method includes a step of determining which of the short fasteners 12a, medium fasteners 12b, or long fasteners 12c should be used for a particular application. This determining step may be determined by experimentation, experience, or professional judgment on the part of the user of tool 10. For example, it has been learned through previous testing that long fastener 12c having a fastener length FL of about 1 inch may not be ideal for fastening a thin metal work piece 4, like metal tracking, to a hard substrate 2, such as concrete or steel, as described above, so that short fastener 12a having a length FL of about ½ inch may be preferred. In contrast, short fastener 12a may not be long enough to extend through a thicker work piece, such as a ¾ inch thick plywood substrate, so that long fastener 12c may be preferred for the latter application.

[89] In summary, a fastener driving tool according to the present invention allows a user

to drive fasteners of various lengths while reducing the risk of shorter fasteners diving back into the magazine and jamming or damaging the tool, while improving guidance of longer fasteners. The tool may provide a telescoping nosepiece that remains abutted against the work surface when the rest of the tool recoils due to the firing of the tool while providing a fixed loading position. Collations according to the present invention allow fasteners of various lengths to be driven by a fastener driving tool while reducing the risk of shorter fasteners diving back into the magazine and jamming or damaging the tool.

[90] While the foregoing written description of the invention enables one of ordinary skill to make and use what is considered presently to be the best mode thereof, those of ordinary skill will understand and appreciate the existence of variations, combinations, and equivalents of the specific exemplary embodiment and method herein. The invention should therefore not be limited by the above described embodiment and method, but by all embodiments and methods within the scope and spirit of the invention as claimed.

Claims

[1] A collation for transporting fasteners along rails disposed within a magazine of a fastener driving tool, comprising:
a plurality of sleeves for supporting and carrying said plurality of fasteners through said magazine, each of said plurality of sleeves having a front and a predetermined length of between about ¼ and about 0.4 inch, each of said plurality of fasteners having a predetermined fastener length of between about ¾ inch and about 1 ½ inch and a tip located at a predetermined position from about 0.05 inch behind said front to about ¼ inch beyond said front;
a plurality of frangible bridges integrally connecting said plurality of sleeves together in a serial array and facilitating the separation of a leading one of said plurality of sleeves from remaining ones of said plurality of serially arranged sleeves when a drive member of said fastener driving tool drives a leading one of the plurality of fasteners disposed within said leading one of said plurality of sleeves; and
a plurality of protrusions from said plurality of sleeves for engaging said rails.

[2] A collation according to claim 1, wherein said plurality of protrusions include contact tip regions for engaging surface portions of said rails.

[3] A collation according to claim 1, wherein each tip protrudes beyond said front of said sleeve so that each fastener has a predetermined exposed tip length, wherein each fastener includes an exposed neck having a length that is at least about as long as said predetermined exposed tip length.

[4] A collation according to claim 1, wherein each tip protrudes beyond said front of said sleeve so that each fastener has a predetermined exposed tip length, wherein each fastener includes an exposed neck having a length that is at least approximately twice said predetermined exposed tip length.

[5] A system of collations for supplying fasteners of at least two different lengths to a fastener driving tool, comprising:
a plurality of first collations each having a plurality of sleeves each having a front, said sleeves holding first fasteners having a tip located at a predetermined position relative to said front; and
a plurality of second collations each having a plurality of second sleeves each having a front, said second sleeves holding second fasteners having a tip located at said predetermined position relative to said front of said second sleeves, wherein said second fasteners are of different length than said first fasteners.

[6] A system according to claim 5, further comprising a plurality of third collations each having a plurality of third sleeves each having a front, said third sleeves

holding third fasteners having a tip located at said predetermined position relative to said front of said third sleeves, wherein said third fasteners are of different length than said first fasteners and said second fasteners.

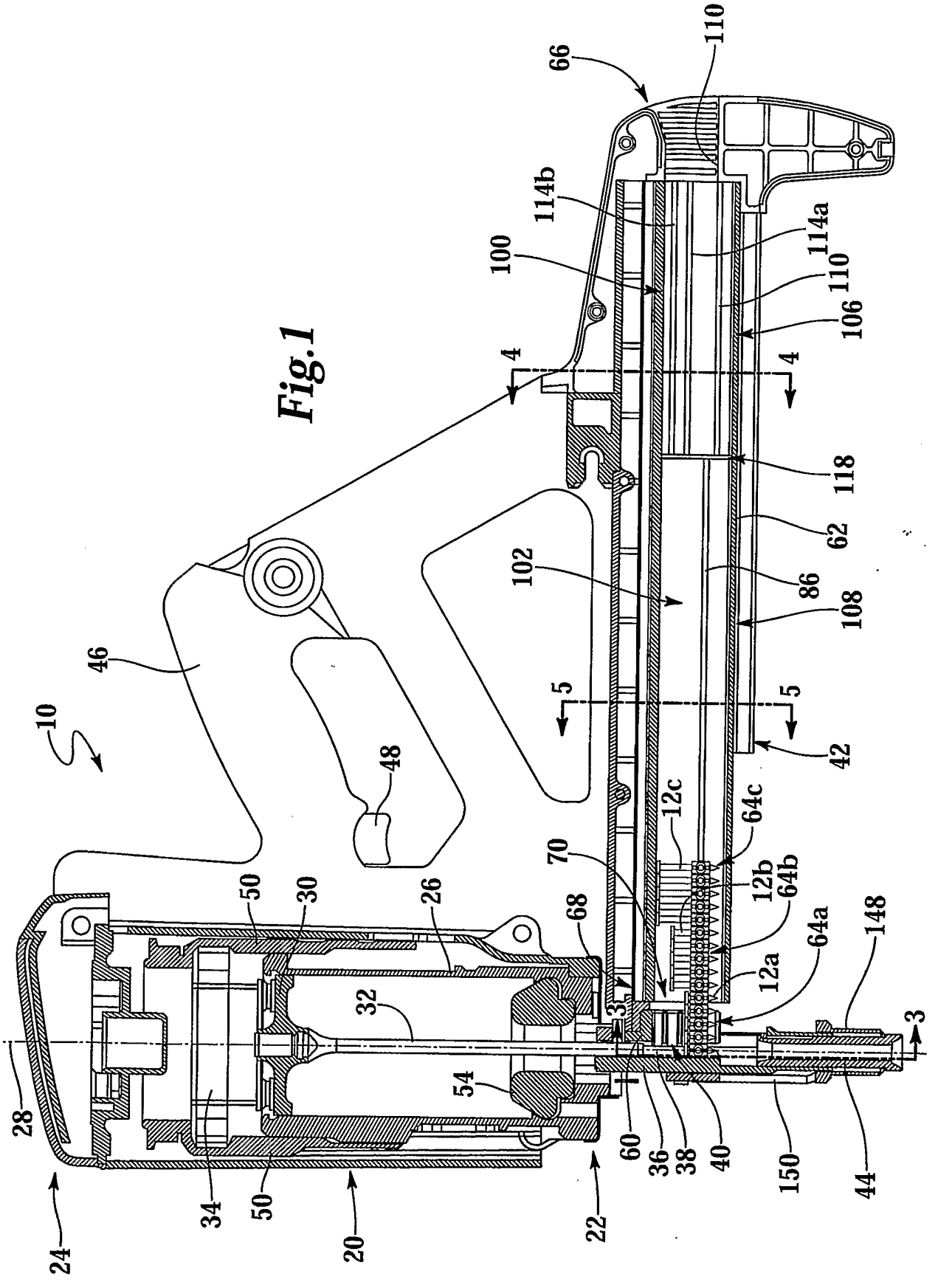

66
110
114b
114a
100
110
106
4
4
118
62
102
86
108
46
5
5
42
10
48
12c
64c
70
12b
64b
50
30
26
68
64a
148
12a
32
3
3
28
54
60
36
38
40
150
44
34
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20
22
24

Fig.1

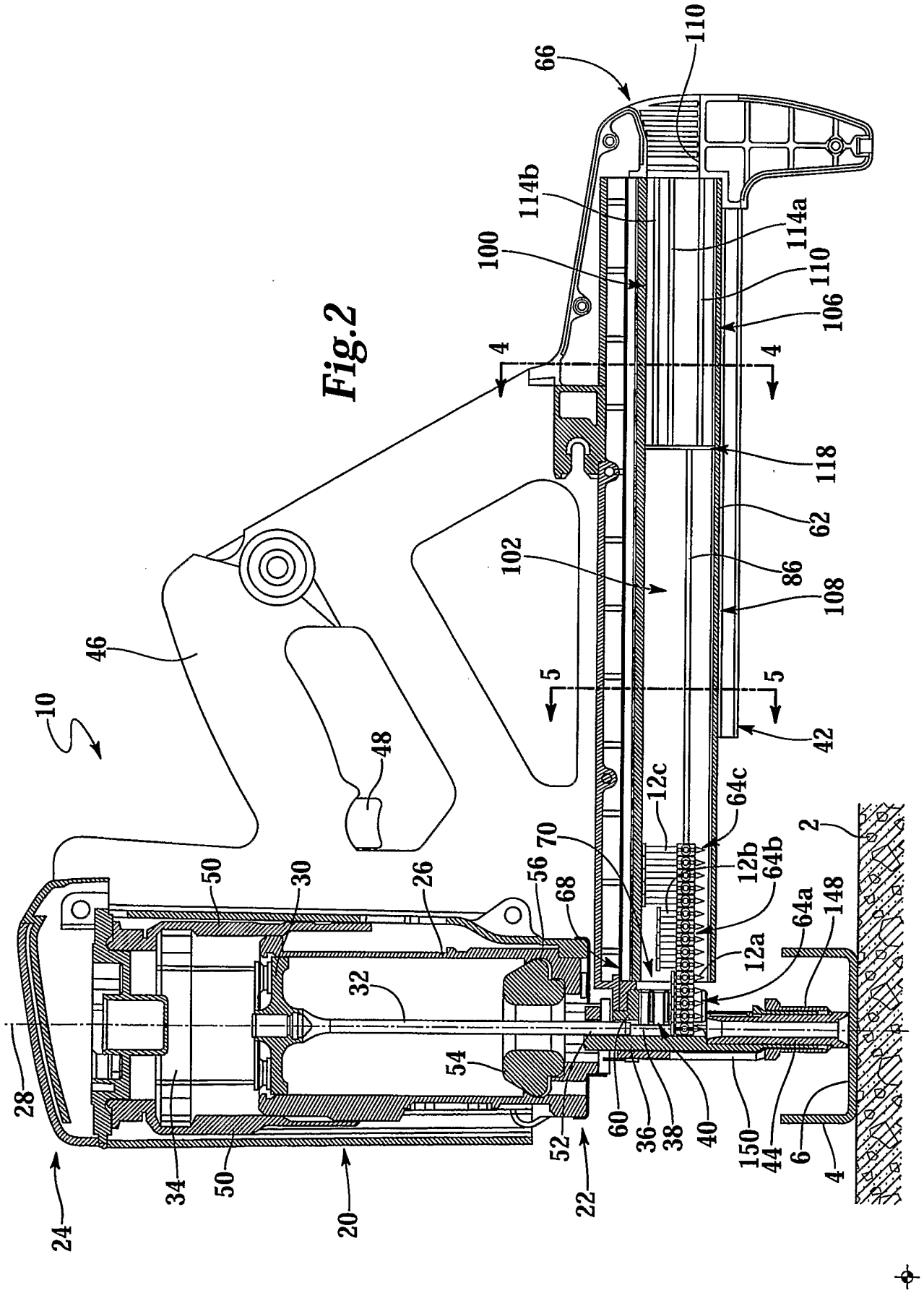

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5
4
4
66
110
114b
100
114a
110
106
118
62
102
86
108
42
12c
64c
12b
64b
64a
148
12a
2
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36
38
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150
44
6
4

Fig.2

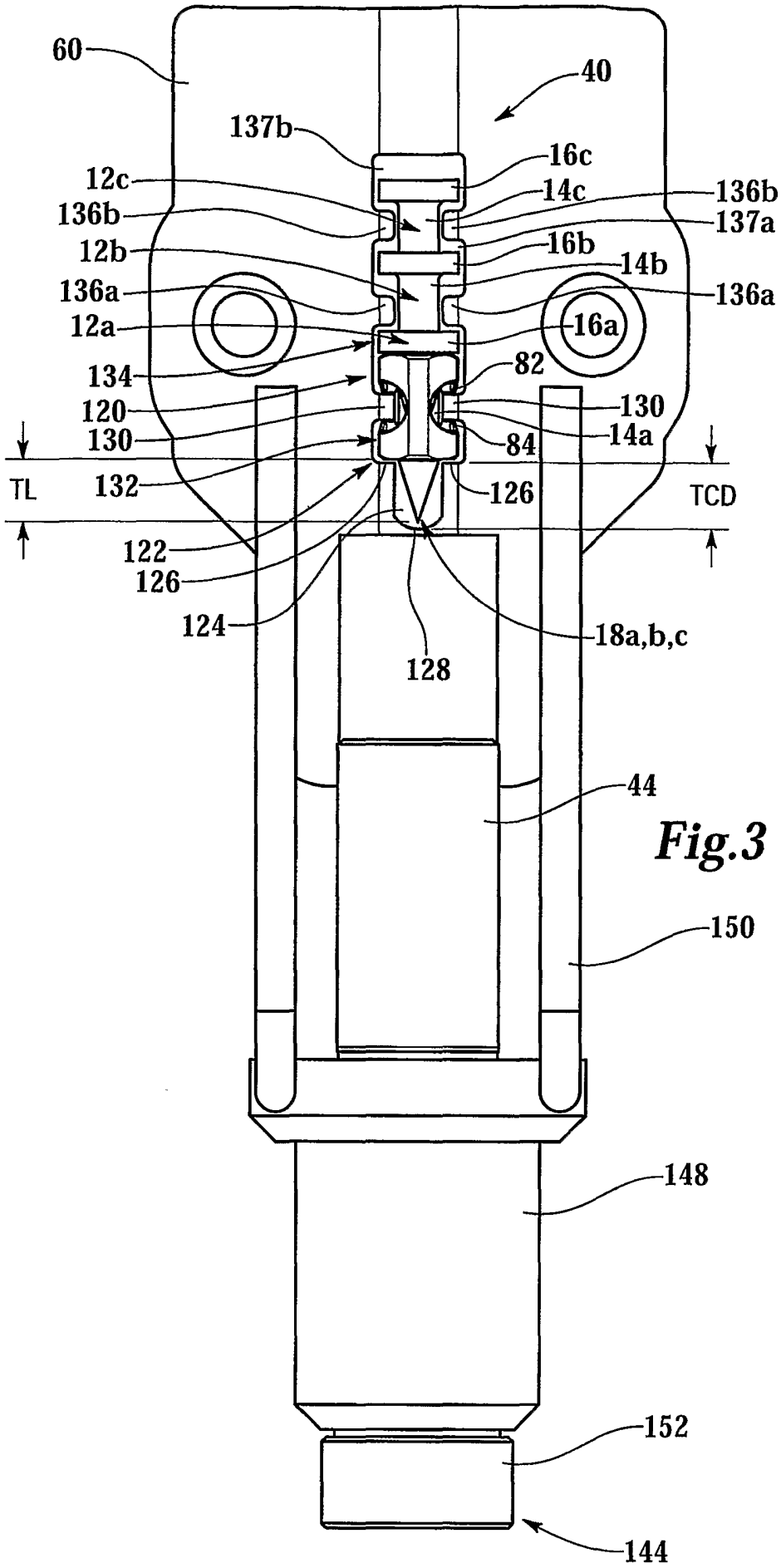

60
40
137b
16c
12c
14c
136b
136b
137a
12b
16b
14b
136a
136a
12a
16a
134
82
120
130
130
14a
84
TL
132
126
TCD
122
126
124
18a,b,c
128
44
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148
152
144

Fig.3

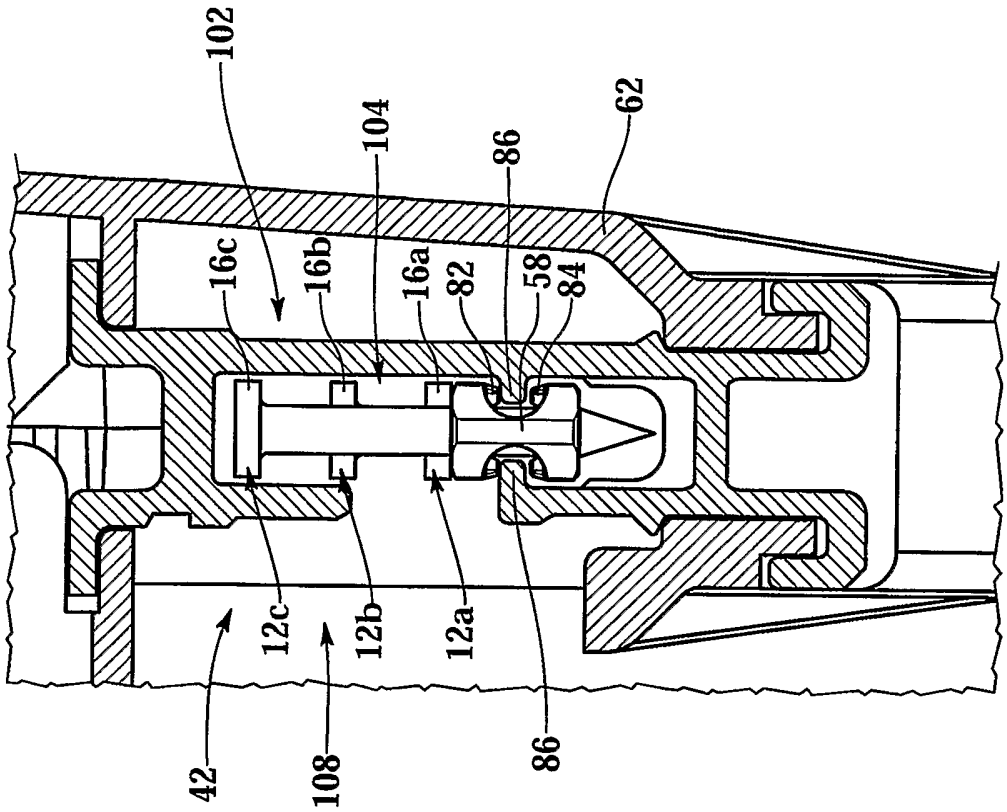

102
104
86
62
16c
16b
16a
82
58
84
12c
12b
12a
42
108
86

Fig.5

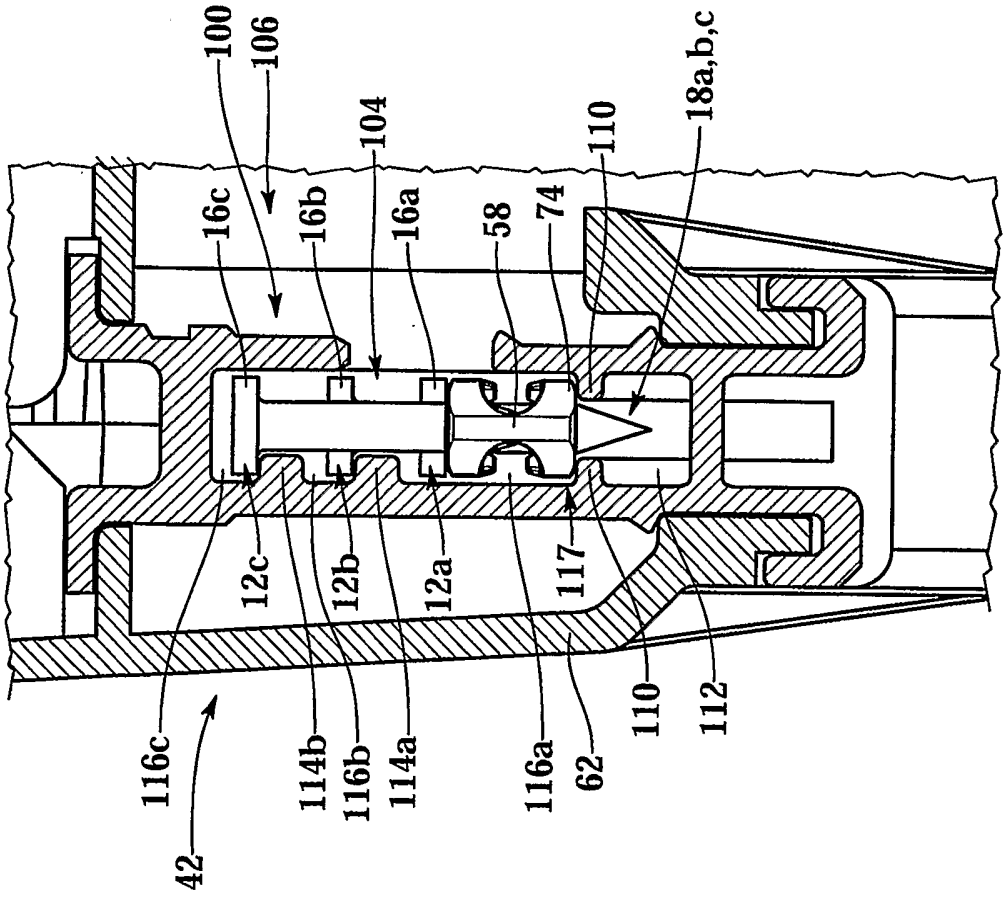

100
106
104
110
18a,b,c
16c
16b
16a
58
74
12c
12b
12a
117
116c
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116b
114a
116a
62
110
112
42

Fig.4

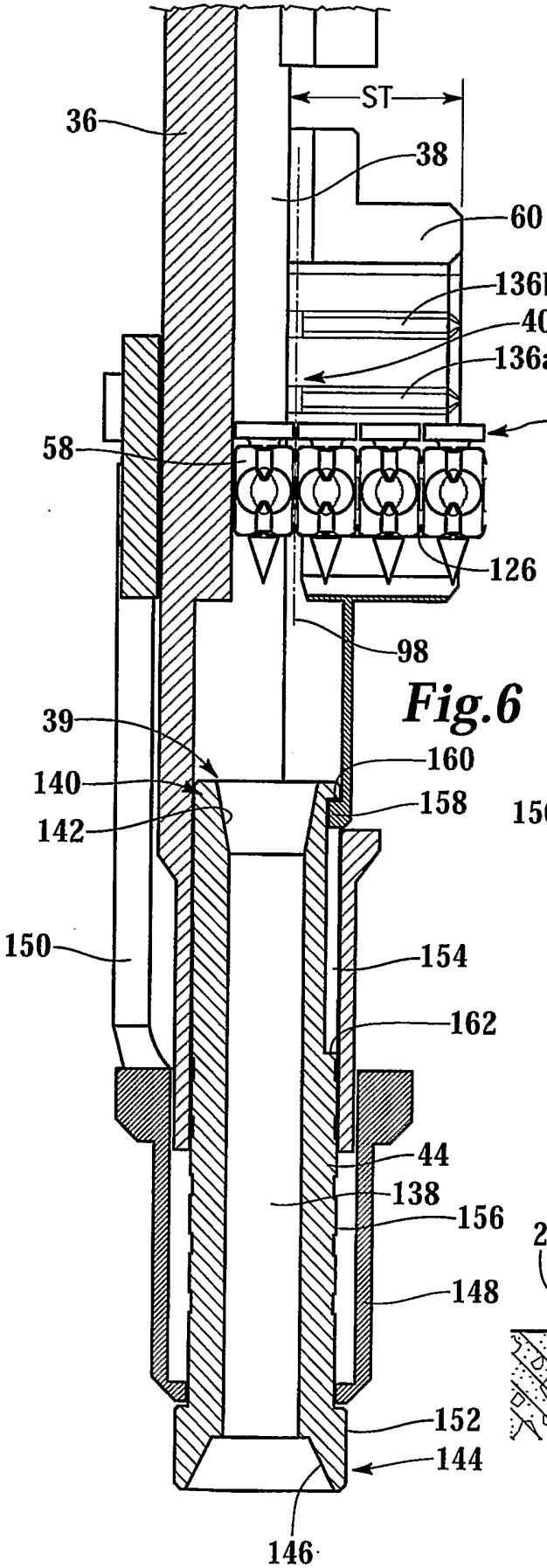

ST
36
38
60
136b
40
136a
12a
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126
98
39
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152
144
146

Fig.6

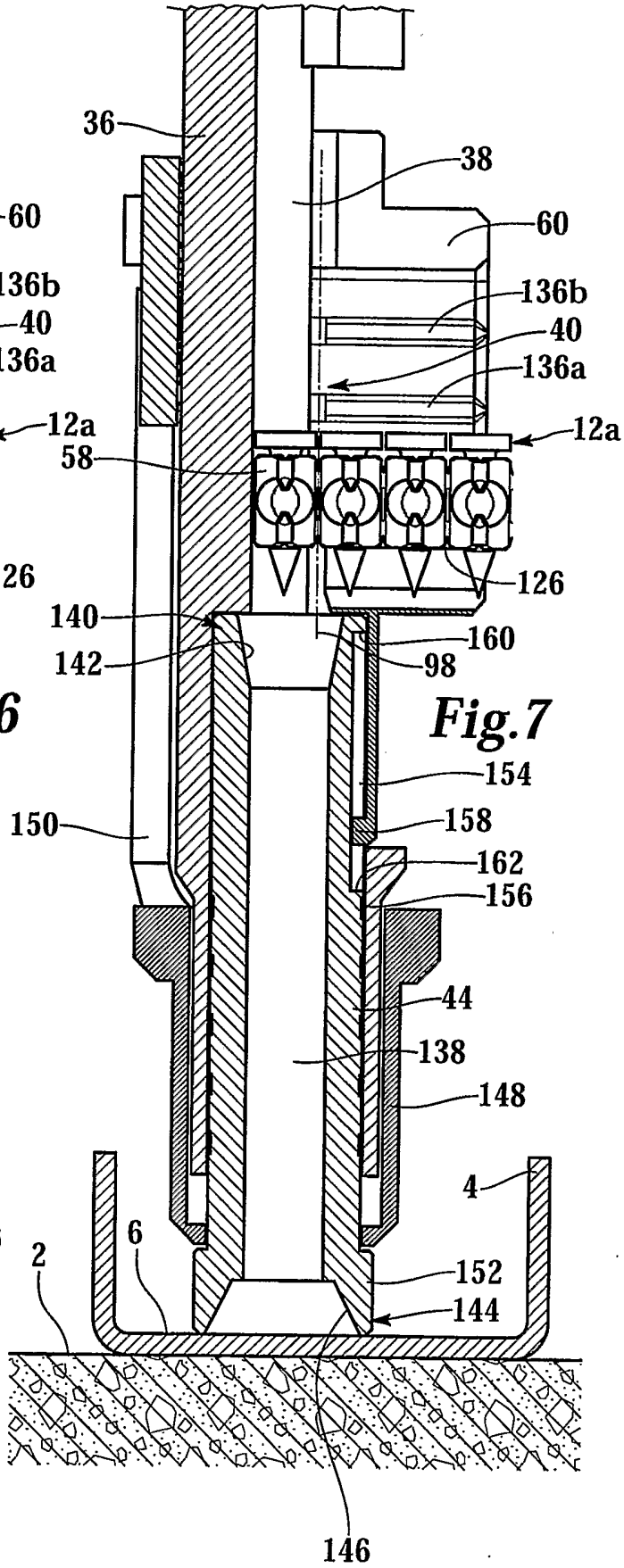

36
38
60
136b
40
136a
12a
58
126
140
142
160
98
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158
150
162
156
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4
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2
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144
146

Fig.7

Fig.8A

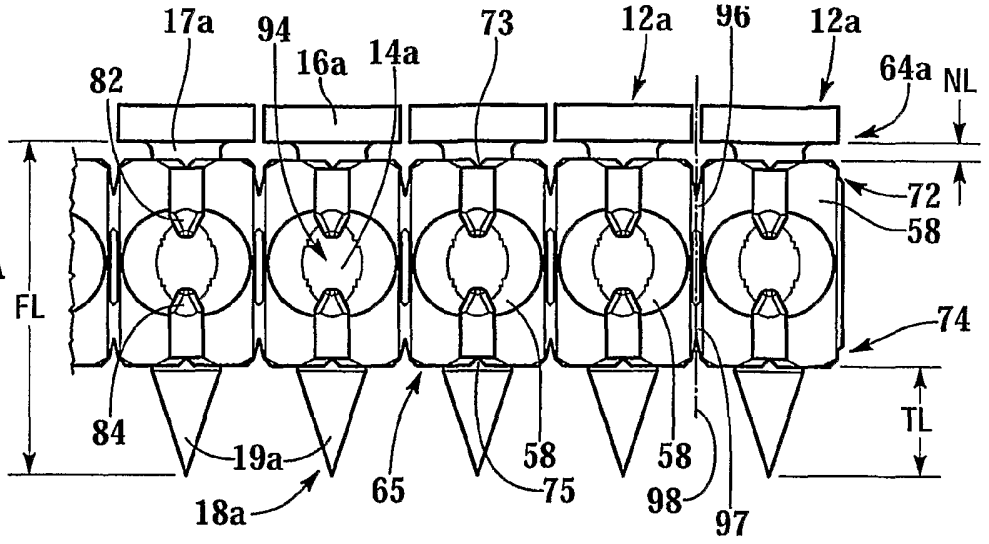


Fig.8B

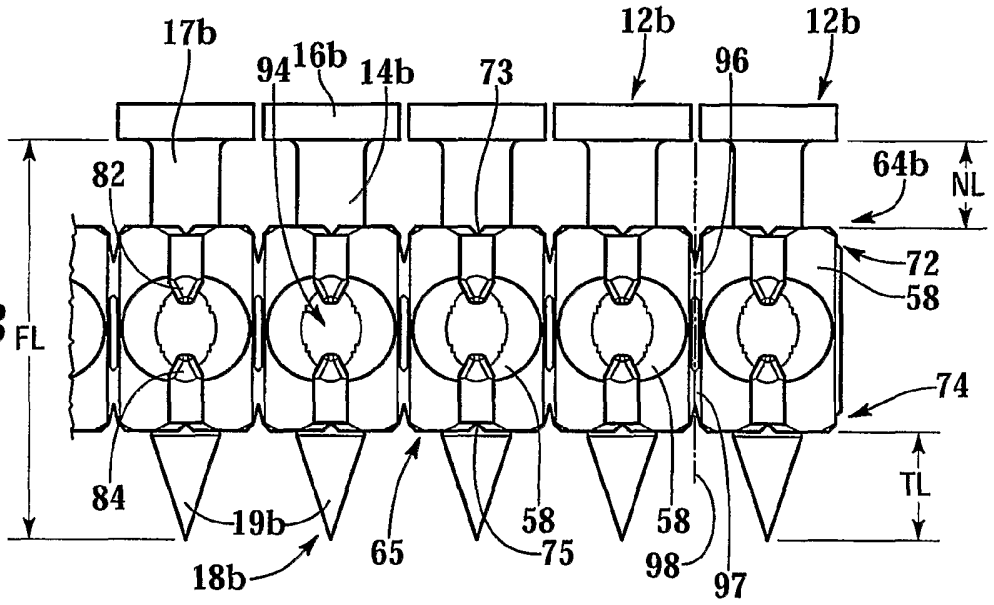
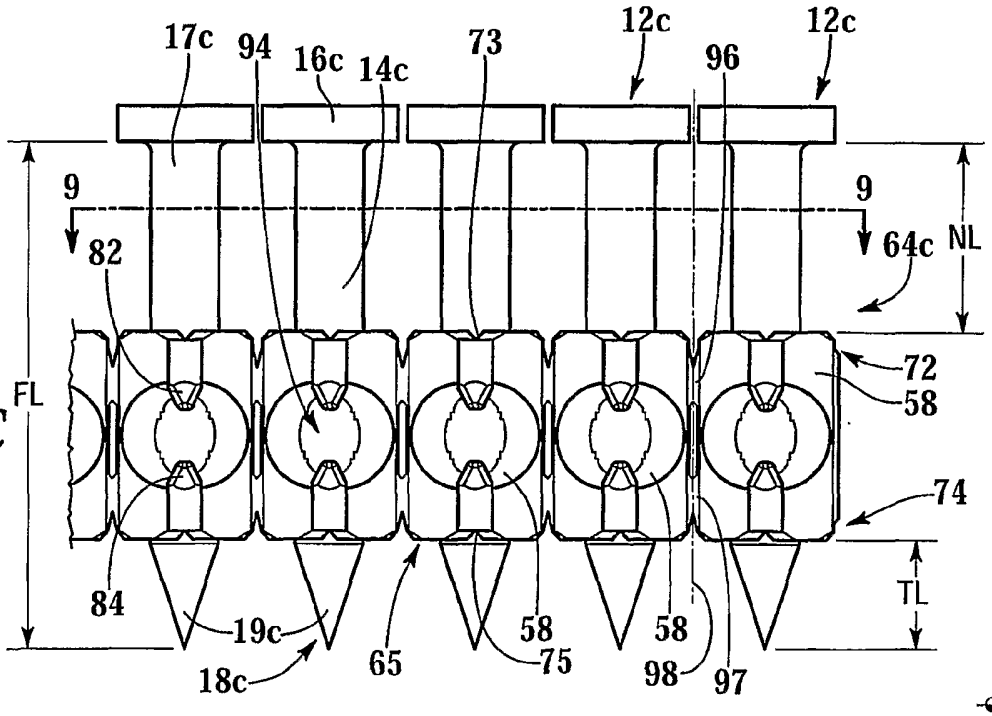


Fig.8C



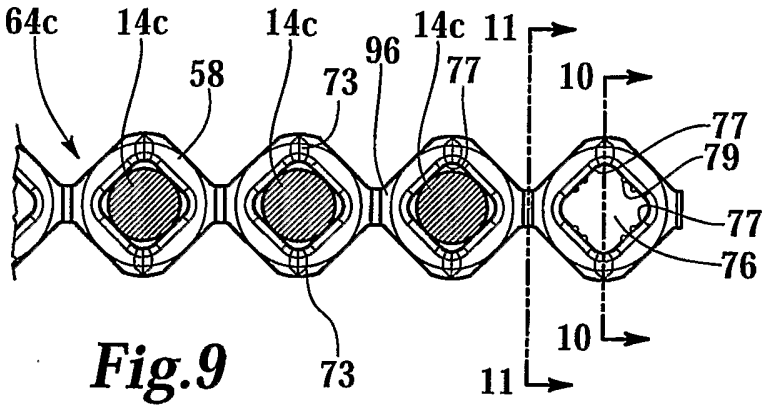


Fig.9

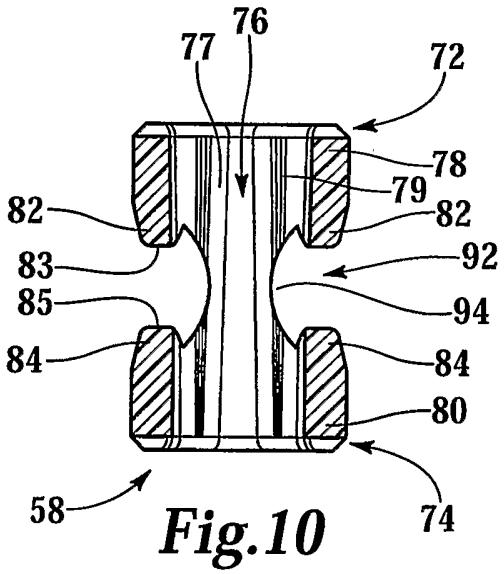


Fig.10

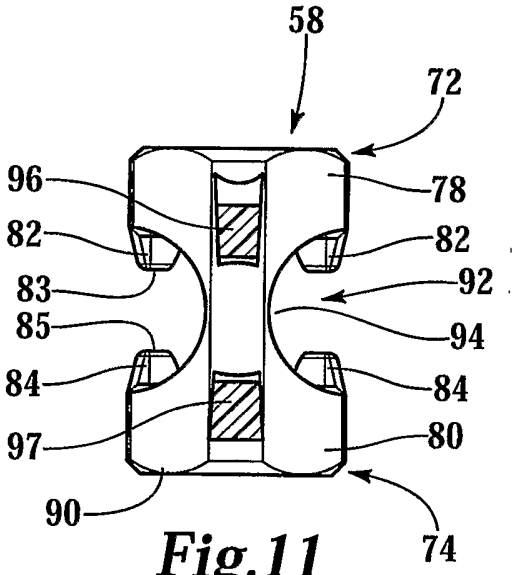


Fig.11

INTERNATIONAL SEARCH REPORT

PCT/IB2005/051439

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16B27/00 F16B15/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16B B25B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 106 618 A (HAYTAYAN ET AL) 15 August 1978 (1978-08-15) column 6, line 18 - line 37; figures 9-11	1-4
X	EP 0 479 382 A (MONACELLI, UMBERTO) 8 April 1992 (1992-04-08)	5,6
A	column 2, line 50 - line 54; figures 2,3	1,3,4
X	US 6 109 144 A (MURO ET AL) 29 August 2000 (2000-08-29)	5
A	column 4, line 35 - line 45; figures 6(A),6(B)	1,3,4
A	US 2003/136693 A1 (GUPTA HARISH C) 24 July 2003 (2003-07-24) claims; figures	1-6

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
5 August 2005	23/08/2005

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 391 616 A (ILLINOIS TOOL WORKS INC) 25 February 2004 (2004-02-25) abstract; figures	1-6
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