United States Patent [19]

Hallock

[11] **3,871,264**

[45] **Mar. 18, 1975**

[54] **DRIVEN FASTENER FOR LIMITED PENETRATION OF METAL**

[76] Inventor: **Robert L. Hallock,** 7136 N.E. 8th Dr., Boca Raton, Fla. 33432

[22] Filed: **Nov. 27, 1972**

[21] Appl. No.: **309,851**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 172,381, Aug. 17, 1971, abandoned.

[52] **U.S. Cl.** **85/30,** 151/41.73

[51] **Int. Cl.** **F16b 15/00**

[58] **Field of Search** ..... 85/30, 31, 10, 10 E; 52/753 L; 151/70, 41.73; 403/242, 244

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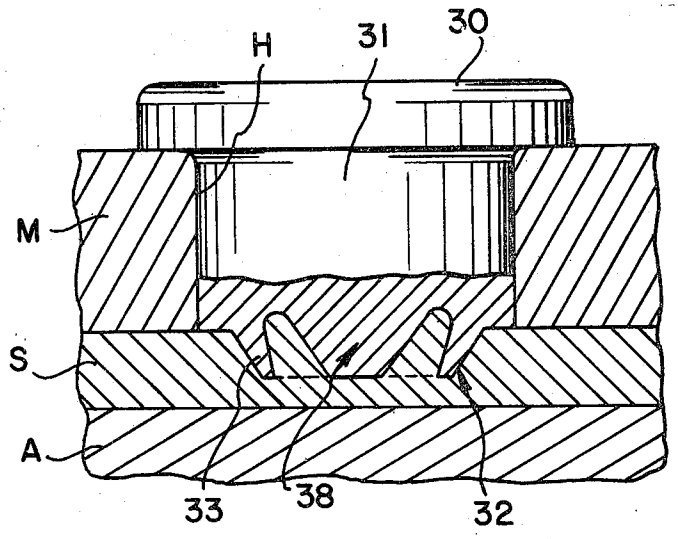
Primary Examiner—Edward C. Allen

Attorney, Agent, or Firm—A. Yates Dowell, Jr.

[57] **ABSTRACT**

A fastener having a shank with a head at one end and a hardened penetrating portion at the opposite end with a frustoconical exterior wall terminating in a penetrating end. The penetrating portion includes a recess having a transverse wall axially spaced from the penetrating end and at least a portion of the transverse wall extends laterally outwardly of the penetrating end to provide an undercut portion. The fastener is adapted to be driven into a hard material so that the hard material flows into the undercut portions of the fastener without deforming the penetrating portion of the fastener.

6 Claims, 27 Drawing Figures



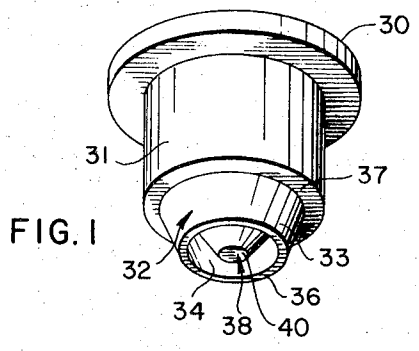


FIG. 1

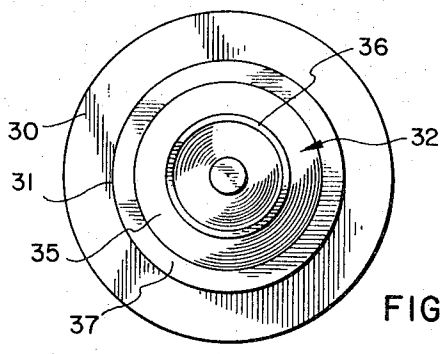


FIG. 2

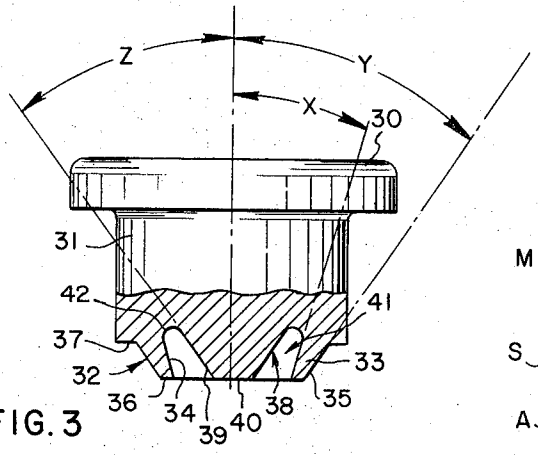


FIG. 3

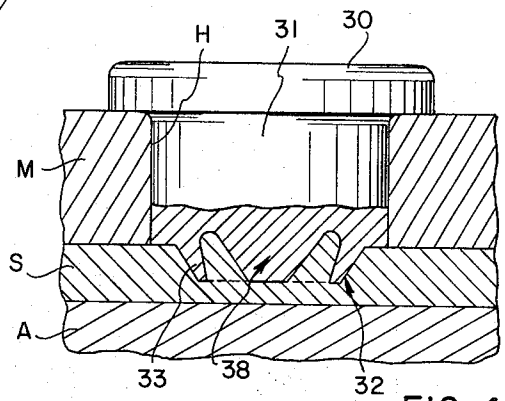


FIG. 4

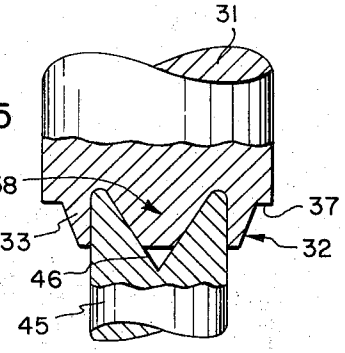


FIG. 5

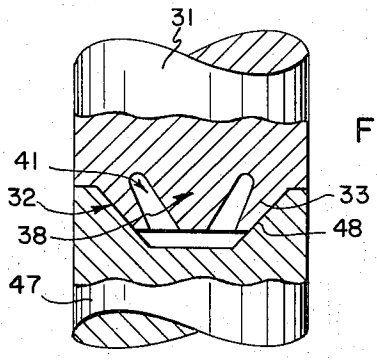


FIG. 6

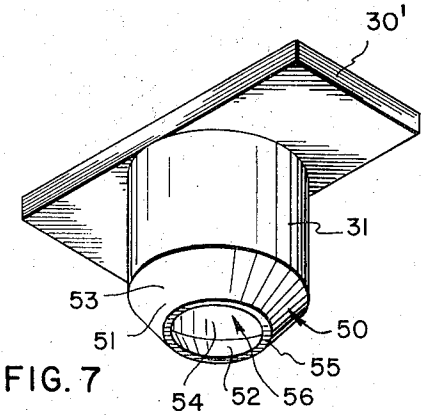


FIG. 7

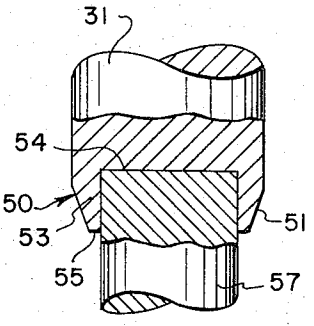


FIG. 8

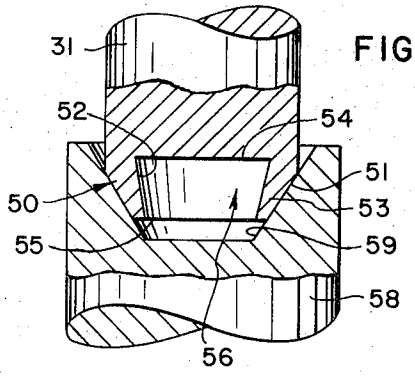


FIG. 9

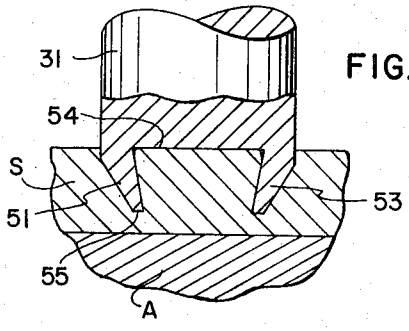


FIG. 10

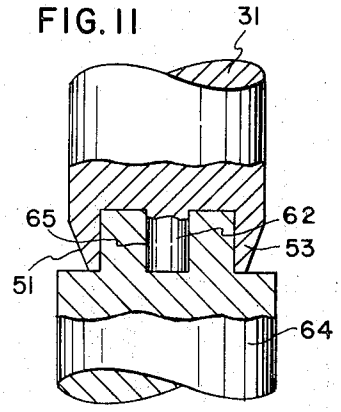


FIG. 11

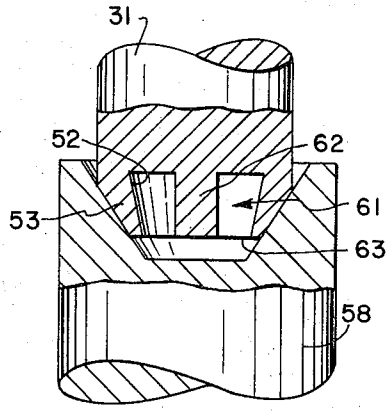


FIG. 12

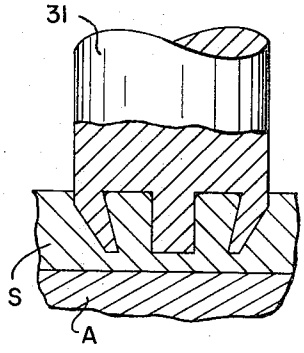


FIG. 13

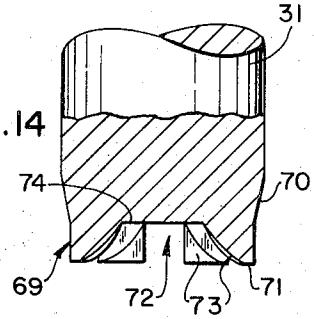


FIG. 14

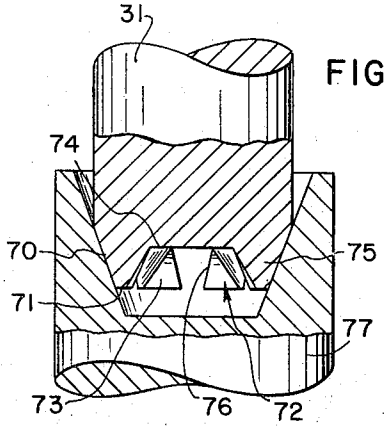


FIG. 16

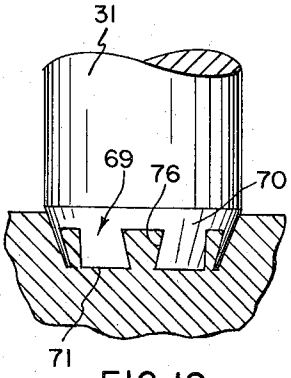


FIG. 18

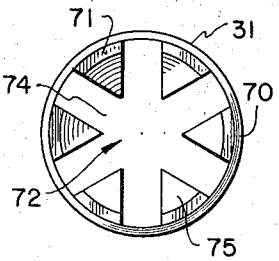


FIG. 15

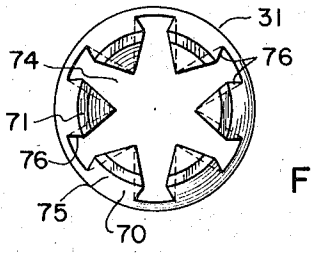


FIG. 17

FIG. 19

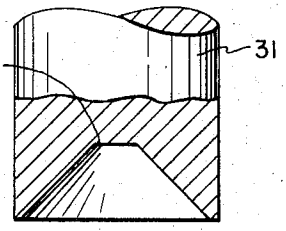


FIG. 20

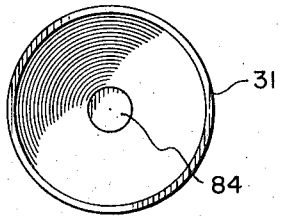


FIG. 21

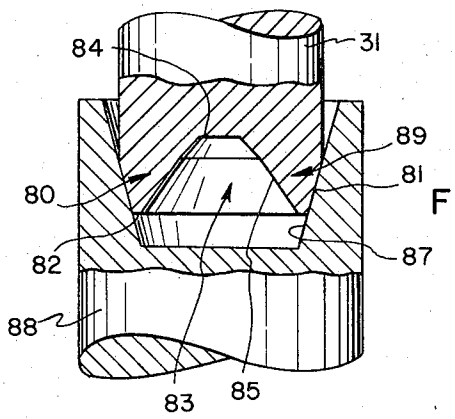


FIG. 22

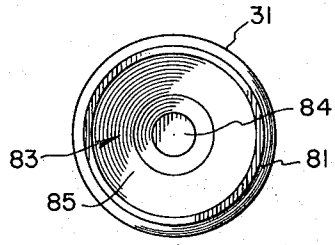


FIG. 23

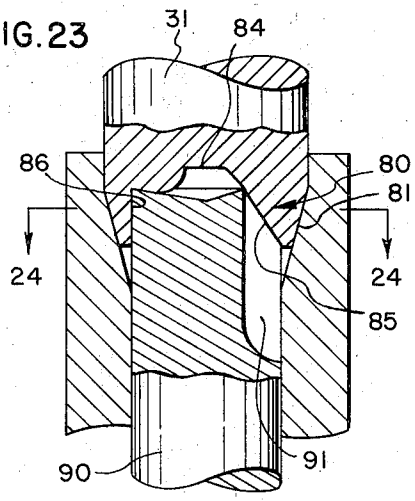


FIG. 24

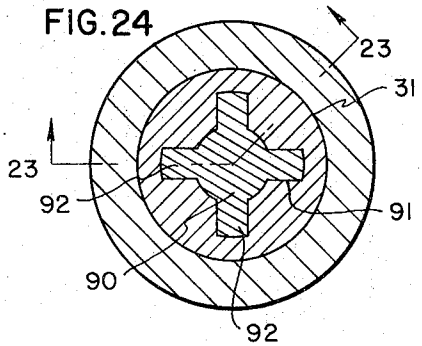


FIG. 25

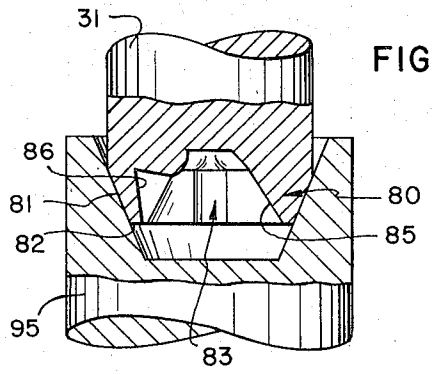


FIG. 26

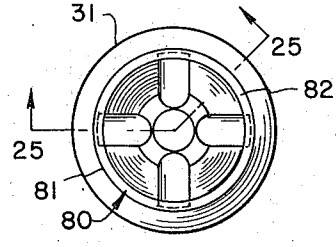
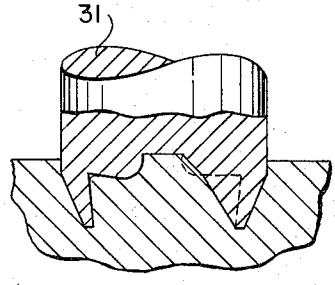


FIG. 27



DRIVEN FASTENER FOR LIMITED PENETRATION OF METAL

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of application Ser. No. 172,381 filed Aug. 17, 1971 and now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to fasteners of various kinds and relates particularly to fasteners which penetrate into metal or other hard material for a limited distance but do not penetrate entirely through such material.

2. Description of the Prior Art

Heretofore many fasteners such as nails, screws, rivets and the like have been provided for attaching various articles in assembled relationship. Frequently nails and screws do not penetrate entirely through the articles, while other fasteners such as other machine screws, rivets and the like extend entirely through the articles and are fastened thereto by nuts or by being peened over.

Some efforts have been made to provide a fastener adapted to penetrate a limited amount into hard materials such as sheet metal and the like and to grip the metal without penetrating entirely therethrough by deforming the penetrating portion of the fastener. An example of this type of prior art structure is my U.S. Pat. No. 3,095,777 in which a fastener is described having a driven end which partially penetrates the metal and the penetrating end is deformed to engage a mass to form a swivel-type connection.

Other patents disclosing fasteners with points in which portions are provided which are intended to engage the material into which driven are represented by patents such as Morahan U.S. Pat. No. 44,212 for boot and shoe nails, Trimbach et al U.S. Pat. No. 1,871,481 for a wedge which is driven into wood, Tucker U.S. Pat. No. 2,048,234 for a roofing nail, King U.S. Pat. No. 2,329,471 for an electrical terminal which is embedded in a support, Stuber U.S. Pat. No. 2,346,625 for a holder for venetian blinds which is embedded in a mass of wood, Cohn U.S. Pat. No. 2,612,813 for an attaching means for wood, Sanford U.S. Pat. No. 3,211,043 for a toothed connector plate, and British patent No. 21,737 of 1898 to Watwood for various types of pronged connectors.

While these patents, except for my own patent, disclose the general idea of fasteners with driven end portions which engage the material, they are intended to be embedded at a substantially greater depth and generally operate on different principles than that of the present fastener.

SUMMARY OF THE INVENTION

The present invention is a fastener for limited penetration into metal and which has a hardened penetrating portion terminating in a penetrating end and an interior or central recess defining a transverse wall spaced from the penetrating end. At least portions of the transverse wall extend laterally outwardly beyond the penetrating end to form an undercut portion of such configuration that when the fastener is driven, the penetrating portion penetrates the sheet material to a limited depth and causes the metal into which the fastener is driven to be deformed and flow into the undercut portions so that a rigid and secure connection is formed which substantially resists withdrawal of the fastener from the metal or other material into which it is driven.

It is an object of the invention to provide a fastener having a hardened penetrating portion with an undercut recess for limited penetration into metal without deforming the penetrating portion but causing the metal into which the fastener is driven to be upset and flow into the undercut portions to form a secure rigid attachment without entirely penetrating the metal.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective illustrating a first embodiment of the invention.

FIG. **2** is an end elevation thereof.

FIG. **3** is a side elevation with portions broken away for clarity.

FIG. **4** is a sectional view illustrating one application of the invention.

FIG. **5** is a fragmentary sectional view illustrating a first step in forming the fastener of FIG. **1.**

FIG. **6** is a fragmentary sectional view illustrating a second step in forming the fastener of FIG. **1.**

FIG. **7** is a perspective illustrating a second embodiment of the invention.

FIG. **8** is a fragmentary sectional view illustrating a step in forming the fastener of FIG. **7.**

FIG. **9** is a fragmentary sectional view illustrating another step in the formation thereof.

FIG. **10** is a fragmentary sectional view illustrating the fastener of FIG. **7** in use.

FIGS. **11** and **12** are fragmentary sectional views illustrating the forming steps of a third embodiment of the invention.

FIG. **13** is a fragmentary sectional view illustrating the fastener of FIGS. **11** and **12** in use.

FIG. **14** is a fragmentary sectional view of a step in the formation of a fourth embodiment of the invention.

FIG. **15** is an end elevation thereof.

FIG. **16** is a fragmentary sectional view of another step in the formation thereof.

FIG. **17** is an end elevation thereof.

FIG. **18** is a fragmentary side elevation illustrating the use of the fourth embodiment.

FIG. **19** is a fragmentary sectional view of a first step in the formation of a fifth embodiment of the invention.

FIG. **20** is an end elevation thereof.

FIG. **21** is a fragmentary section of a second step.

FIG. **22** is an end elevation thereof.

FIG. **23** is a fragmentary sectional view of a third step on the line **23—23** of FIG. **24.**

FIG. **24** is a section on the line **24—24** of FIG. **23.**

FIG. **25** is a fragmentary sectional view of a fourth step on the line **25—25** of FIG. **26.**

FIG. **26** is an end elevation thereof.

FIG. **27** is a fragmentary sectional view illustrating the fifth embodiment in use.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Each embodiment of the fastener of the present invention includes a head or driving end **30** on one end of a shank **31** which may be of variable length according to the application. The opposite end of the shank includes a penetrating portion which penetrates only

partially into metal or other relatively dense material. The metal into which the fastener is driven can be relatively soft thin sheet material or can be relatively hard structural steel. The fasteners illustrated in FIGs. 1–13 normally partially penetrate sheet material such as sheet steel and the fasteners illustrated in FIGS. 14–27 normally are used to partially penetrate structural steel members.

With particular reference to FIGs. 1–6, the shank 31 terminates in a penetrating portion 32 having a rim 33 defined by an inner wall 34, an outer wall 35, and a forward extremity or penetrating end 36. The outer wall 35 is spaced inwardly of the circumference of the shank 31 to provide a ledge 37 which restricts penetration of the penetrating portion 32.

The rim 33 is disposed outwardly of an interior or central portion 38 of substantially conical shape and having an outer tapered wall 39 and a forward extremity or nose 40. The substantially facing inner wall 34 of the rim 33 and the outer wall 39 of the interior portion terminate in spaced relation, thereby providing a valley or recess 41 with a bottom or generally transverse wall 42. The bottom 42 is located laterally outwardly of the penetrating end 36 to provide an undercut. The penetrating end 36 and the nose 40 of the interior portion lie in a common plane transverse to the axis of the fastener.

The inner and outer walls of the rim 33 are inclined at an angle toward the axis and in the direction from the head or the driving end 30. This angle may be selected according to the particular application, the depth of penetration, the amount of driving force to be applied, and the nature of the material into which it is driven. For driving into ordinary sheet metal, it has been found that the angle "x" of the inner wall 34 may be on the order of approximately 10° and angle "y" of the outer wall 35 may be approximately 25°. The angle "z" of the outer wall 39 of the interior portion is preferably greater than the angle x of the inner wall 34 in order to provide a diverging valley 41 and may be on the order of 20° or approximately 10° greater than that of the angle x.

In order to form the penetrating portion 34, as illustrated in FIGS. 5 and 6, the shank 31 is formed of any desirable material such as 1050 mild steel with the outer wall 35 of the rim 33 being formed at an angle of approximately 15°. With the shank 31 being held in fixed position, a forming die 45 having a conical recess 46 with an included angle of approximately 40° is forced into the end of the shank for a desired distance. The forming die 45 forms the frusto-conical central portion 38 of the fastener and forms the inner wall 34 into a substantially cylindrical wall generally concentric with the periphery of the shank. After the central portion 38 has been formed by the die 45, a second forming die 47 having a frusto-conical recess 48 is forced onto the outer wall 35, as illustrated in FIG. 6. The recess 48 is disposed at an included angle of approximately 50° so that the rim 33 and the penetrating end 46 are compressed and moved inwardly so that the bottom 42 of the valley 41 is undercut relative to the penetrating end. After the penetrating portion 32 has been formed, the fastener is heat treated and hardened to a hardness of approximately Rockwell C 50-55.

With particular reference to FIG. 4, the fastener is utilized to connect a material M to sheet material S. In this modification, the material M is provided with a preformed hole H and the shank 31 of the fastener is placed within such hole with the penetrating portion 32 engaging the sheet metal S. The sheet metal is placed on a hard backing member or anvil A after which a hammer (not shown) is used to drive the fastener into the sheet metal. As the fastener is driven, material from the sheet is upset and is forced to flow upwardly and outwardly into the valley 41. Since the material within the valley flows outwardly beyond the penetrating end 36, the fastener remains attached to the sheet metal S. The penetrating portion 32 of the fastener is harder than the metal of the sheet material and therefore the penetrating portion retains its shape while the metal into which the fastener is driven is forced to flow into and completely fill the valley 41.

With reference to FIGS. 7–10, the fastener is provided with a generally rectangular shaped head 30' so that a plurality of fasteners can be connected together by weakened portions to form a string of fasteners received within a force applying gun or the like in the manner of conventional staples. In this modification, the penetrating portion 50 includes an outer wall 51 and an inner wall 52 defining a rib 53. The inner wall 52 is connected to a substantially flat horizontally disposed transverse wall 54 axially spaced from the penetrating end 55 and forming a recess 56. As illustrated best in FIG. 8, the recess 56 can be formed by a forming die 57 which is forced upwardly generally axially of the shank 31. After the recess has been formed, a second forming die 58 (FIG. 9) having a frusto-conical recess 59 engages the outer wall 51 of the penetrating portion 50 and causes the rib 53 to be bent inwardly while compacting the penetrating end 55 until the inner wall 52 is disposed at an angle of approximately 10° to the axis of the shank 31.

In this embodiment, when the fastener is driven into sheet metal, a column of metal passes into the recess 56 until such column engages the transverse wall 54 after which the metal of the column is upset and forced to flow outwardly to substantially completely fill the recess.

The embodiment illustrated in FIGS. 11–13 is similar to the embodiment shown in FIGS. 7–10 with the exception that a recess 61 is provided in the end of the shank 31 and such recess includes a generally cylindrical central portion 62 forming an integral part of the shank. The central portion extends downwardly to a position substantially coplanar with the penetrating end 63. In this modification, a forming die 64 having a central opening 65 is forced into the end of the shank and such central opening forms the cylindrical portion 62. This modification is driven into sheet metal S and a doughnut shaped column of metal enters the recess 61 until it reaches the upper transverse wall. Thereafter metal in the column is forced to flow outwardly and completely fill the recess.

The modifications illustrated and described thus far are primarily for use with relatively soft sheet metal such as low carbon sheet steel, aluminum and the like, when driven by a blow from a hammer or impact gun. The penetrating portion of each embodiment of the fastener retains its initial shape and the impact forces the sheet material to flow into the undercut portions of the fastener. In each of these modifications, the undercut portion extends substantially entirely around the recess formed in the penetrating portion of the fastener and when such fasteners are driven into hard material, such

as low carbon structural steel having a hardness in the range of Rockwell B58 to B85 and a thickness in the range of 1/16 inch to ⅜ inch, the penetrating portion has had a tendency to break along a line substantially coextensive with the bottom of the valley or recess. In order to provide a fastener for limited penetration into structural steel members which will not break when subjected to heavy impact blows, the embodiments illustrated in FIGS. **14–27** have been provided.

With particular reference to FIGS. **14–18,** the shank **31** is provided with a penetrating portion **69** including a tapered outer wall **70** terminating in a penetrating end **71.** A recess or valley **72** is provided within the end of the shank and such recess is defined by an inner wall **73** and a generally flat transverse wall **74.** The inner wall **73** is tapered outwardly at an angle of approximately 20° to provide a chisel-shaped rim **75.**

The rim **75** is interrupted by a plurality of dovetail slots **76** extending through the rim to the outer wall **70.** The wider portions of the dovetail slots are substantially in alignment with and form extensions of the transverse wall **74** of the recess, while the narrower portions of such dovetail slots are located at the penetrating end **71.**

The dovetail slots can be formed in any desired manner, as by extruding the end of the shank to the configuration illustrated in FIG. **14** or forming the end of the shank to this configuration by means of a forming die (not shown). In this configuration, the upper portion of the outer wall is formed to the desired finished taper while the lower portion is generally cylindrical. The recess **72** is formed in the end of the shank and thereafter a plurality of straight-sided slots are cut or broached through the rim **75.** After the slots have been formed, the shank is forced into a forming die **77** which upsets the lower rim portions inwardly which in turn causes the lower portions of the straight sides of the groove to move toward each other and form dovetail grooves, as illustrated in FIG. **16.** It is contemplated that the dovetail slots could be produced by forming a continuous rim **75** with the inner and outer walls disposed at an angle to each other and thereafter the dovetail slots **76** could be broached in a conventional broaching operation.

After the fastener has been heat treated and hardened to a hardness of approximately Rockwell C 50-55, the fastener can be driven into relatively hard structural steel. A heavy impact on the driving end of the fastener causes the material into which the fastener is being driven to be upset and to flow into the dovetail slots **76** not only as the fastener is penetrating the metal, but also after a column of metal engages the transverse wall **74** and flows outwardly into the dovetail slots. Due to the chisel-shaped cross-section of the rim portions, the tendency to crack or break is greatly minimized and therefore the fastener will be securely attached to the structural steel by the material within the dovetail grooves.

With particular reference to FIGS. **19–27,** a fastener is provided having undercut segments as disclosed in the first three embodiments interspersed with chisel-shaped segments as disclosed in the fourth embodiment but with a substantially continuous penetrating end. In this modification, the shank **31** is provided with a penetrating portion **80** having an inwardly tapered outer wall **81** terminating at a penetrating end **82.** A recess **83** is formed in the end of the shank **31** and such recess is defined by a transverse wall **84** portions of which are connected to the penetrating end by an outwardly tapered inner wall **85** defining chisel-shaped rim segments, and other portions of the transverse wall are connected to the penetrating end by inwardly tapered inner walls **86** defining undercut portions of the rim interspersed between chisel-shaped portions.

In making the fastener of this embodiment, a conical recess is initially formed in the end of the shank with the side walls of the recess being tapered at an angle of approximately 45° and terminating in the substantially flat transverse wall **84.** The recess can be formed in any desired manner, as by a forming die (not shown). In the next step the end of the shank is forced into a frusto-conical recess **87** of a forming die **88** so that the end of the shank is compressed and forced inwardly to an intermediate position forming a rim **89** having an inwardly tapered outer wall **81** and an outwardly tapered inner wall **85.** In the next step (FIGS. **23** and **24**) a fluted forming die **90** having a plurality of recesses **91** located between land areas **92** is forced into the recess **83** of the shank. The land areas **92** of the forming die **90** cut a plurality of straight-sided grooves into the outwardly tapered inner wall **84** of the recess **83.**

Thereafter a forming die **95** is forced onto the end of the shank to further compact the penetrating end **82** and increase the angle of taper of the outer wall **81** to a finished angle of approximately 25°. Increasing the angle of the outer wall causes the inner wall portions **86** to assume an inwardly tapered configuration to provide an undercut portion. After the fastener has been heat treated and hardened, a heavy impact on the driving end of the fastener causes the fastener to penetrate structural steel without deforming the penetrating portion **80.**

When the fastener is being driven, the chisel-shaped segments of the rim **89** cause the material into which the fastener is being driven to be upset and flow into the recess **83** as well as into the undercut segments located between the chisel-shaped segments. Additionally, a column of material in the undercut segments bottoms against the transverse wall **84** and is forced to flow outwardly into the undercut portions to securely connect the fastener to the structural steel member. Although the fastener of this embodiment is provided with undercut segments, the tendency of the rim **89** to bend inwardly in the area of such undercut segments is greatly reduced since such undercut segments are supported at each side by chisel-shaped segments.

In operation, each embodiment of the fastener is provided with a penetrating portion having an inwardly tapered outer wall terminating in a penetrating end and a recess having a transverse wall spaced axially inwardly from such penetrating end. At least a portion of the transverse wall is located outwardly of the penetrating end so that each of the fasteners is provided with undercut portions into which metal is forced to flow. When an impact or driving force is applied to the head of the fastener, the material into which the fastener is being driven enters the recess in the end of the shank until it engages the transverse wall after which such metal is forced outwardly into the undercut portions to firmly secure the fastener to the metal. When a fastener is being driven into sheet material, a relatively light impact or driving blow can be applied to the head of the fastener and when the fastener is being attached to a relatively hard structural steel member, a heavy impact

force or blow substantially equal to a 3 pound weight dropped twice from a 3 foot height onto a ⅛ inch diameter fastener is required to cause penetration of the fastener into the metal. After the fastener has been attached, a force of approximately 200 to 300 pounds is required to remove the fastener depending upon the hardness of the material.

I claim:

1. A fastener for limited penetration into metal comprising a smooth generally cylindrical shank with an enlarged head at one end and a rigid substantially non-deformable penetrating portion at the other end, said head being engageable by an impact force which is applied generally axially of said shank, said penetrating portion having a generally circumferentially continuous frusto-conical exterior wall tapering inwardly towards the axis of said shank in a direction away from the head and terminating in a penetrating end, said penetrating portion having a recess defined by an inner wall extending from said penetrating end to an abutment wall spaced axially inwardly therefrom, at least portions of said abutment wall extending laterally outwardly of the iinner periphery of said penetrating end, at least portions of said inner wall being inclined outwardly at an angle of substantially **10°** from said penetrating end to said portions of said abutment wall to provide significant undercut portions, and said penetrating portion being hardened so that it is harder than the metal into which it is to be driven, whereby when said fastener is driven substantially axially into metal by impact, the driving force causes said penetrating portion to penetrate the metal until the metal engages said abutment wall and is diverted outwardly into said undercut portions to secure the fastener to the metal and resist withdrawal of the fastener from the metal.

2. The structure of claim **1** including a central portion within said recess, said central portion extending from said abutment wall to a position substantially co-extensive with said penetrating end.

3. The structure of claim **2** in which said central portion is substantially conical in cross-section.

4. The structure of claim **2** in which said central portion is substantially cylindrical.

5. The structure of claim **1** in which other portions of said inner wall are inclined inwardly from said penetrating end to other portions of said abutment wall to provide segments with said exterior wall which are generally conical in cross-section.

6. A fastener for limited penetration into metal comprising a generally cylindrical shank having an enlarged head at one end and a substantially non-deformable penetrating portion at the other end, said head being engageable by an impact force generally axially of said shank, said penetrating portion including a circumferentially continuous exterior wall tapering inwardly towards the axis of said shank in a direction away from said head and terminating in a flattened penetrating end having inner and outer peripheries, said penetrating portion having a recess defined by an inner wall extending upwardly from the inner periphery of said penetrating end to a substantially transverse wall spaced axially therefrom, at least portions of said transverse wall extending laterally outwardly of the inner periphery of said penetrating end, at least portions of said inner wall being inclined outwardly at an angle of substantially 10° from said penetrating end and connected to said portions of said transverse wall to provide significant undercut portions, a substantially conical central portion extending downwardly from said transverse wall to a position substantially co-extensive with said penetrating end, and said penetrating portion being hardened to retain the shape thereof when driven, whereby when said fastener is driven substantially axially into metal by impact, the driving force causes said penetrating portion to penetrate the metal so that the metal engages said central portion and is diverted outwardly to said transverse wall and into said undercut portions to secure the fastener to the metal.

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