Dec. 6, 1966 R. G. FRIEDMAN 3,289,229

APPARATUS FOR COLD HEADING BLANKS

Original Filed Sept. 21, 1960 3 Sheets-Sheet 1

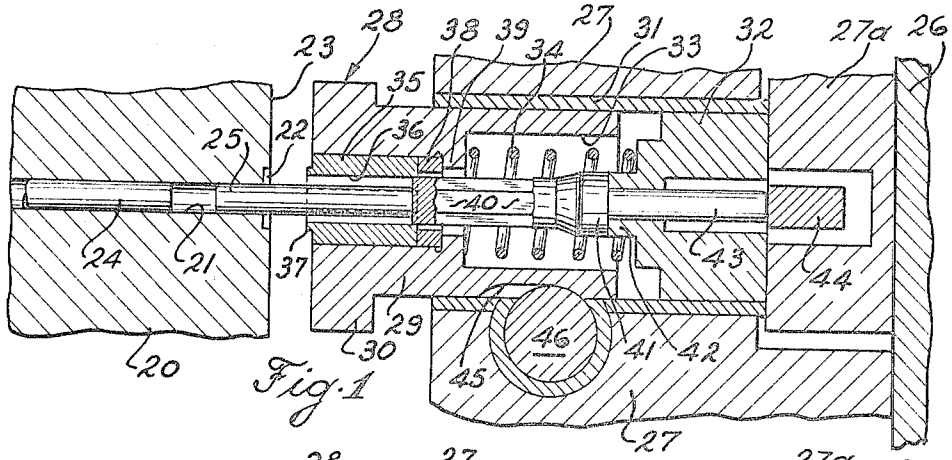


Fig. 1

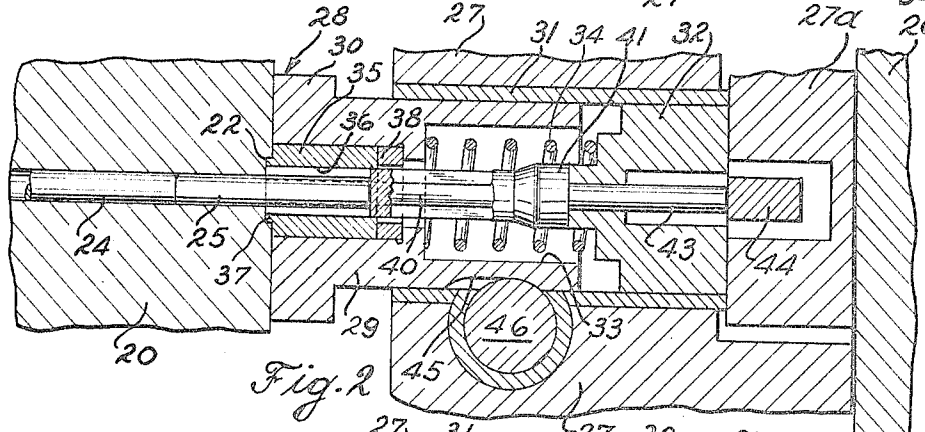


Fig. 2

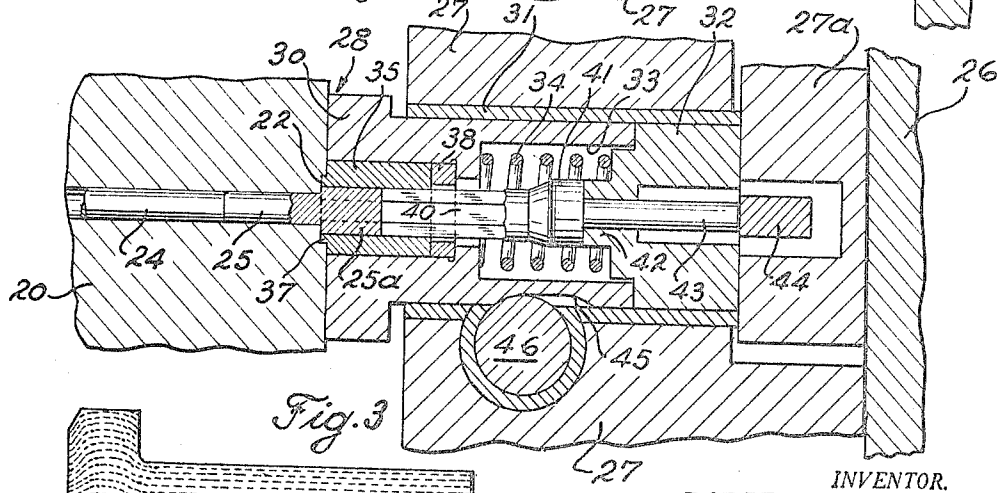


Fig. 3

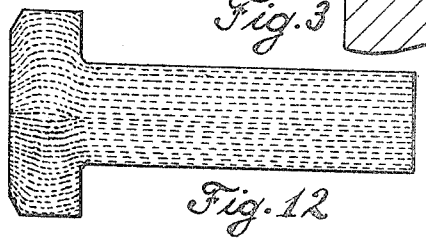


Fig. 12

INVENTOR.
ROBERT G. FRIEDMAN

BY
McNENNY, FARRINGTON, PEARNE & GORDON

ATTORNEYS

Dec. 6, 1966 R. G. FRIEDMAN 3,289,229

APPARATUS FOR COLD HEADING BLANKS

Original Filed Sept. 21, 1960 3 Sheets-Sheet 2

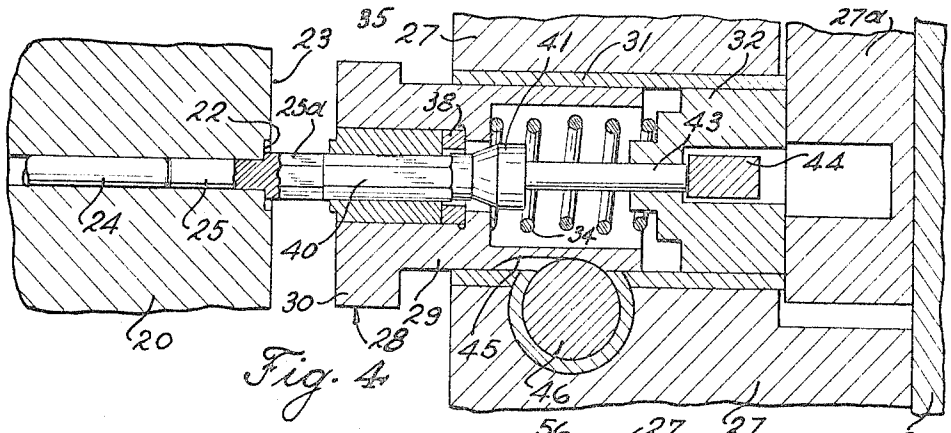


Fig. 4

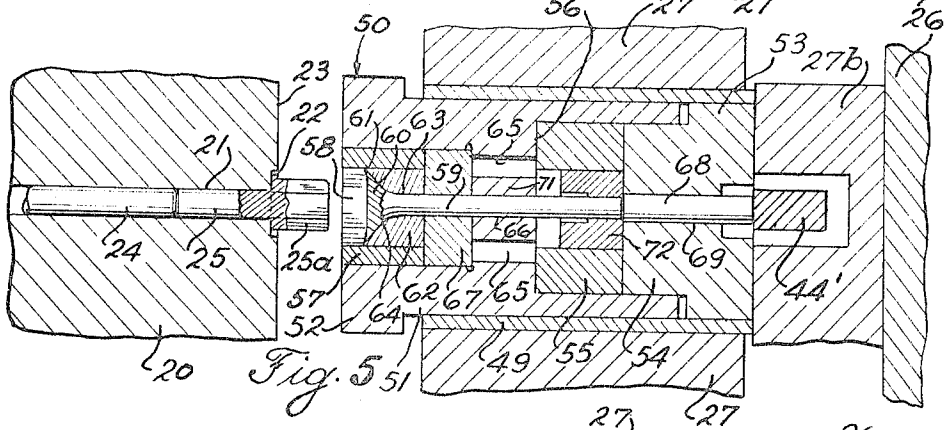


Fig. 5

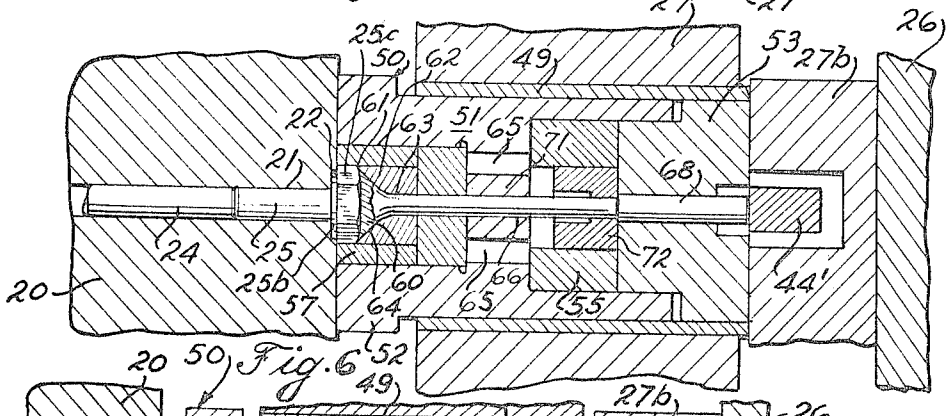


Fig. 6

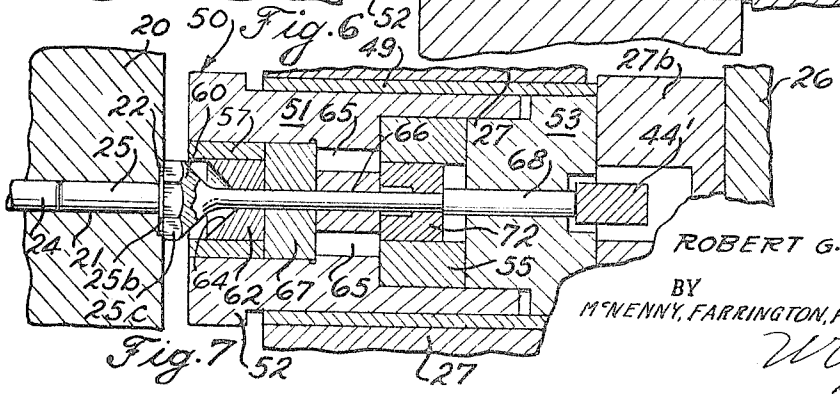


Fig. 7

INVENTOR.
ROBERT G. FRIEDMAN

BY
McNENNY, FARRINGTON, PEARNE & GORDON

ATTORNEYS

Dec. 6, 1966 R. G. FRIEDMAN 3,289,229

APPARATUS FOR COLD HEADING BLANKS

Original Filed Sept. 21, 1960 3 Sheets-Sheet 3

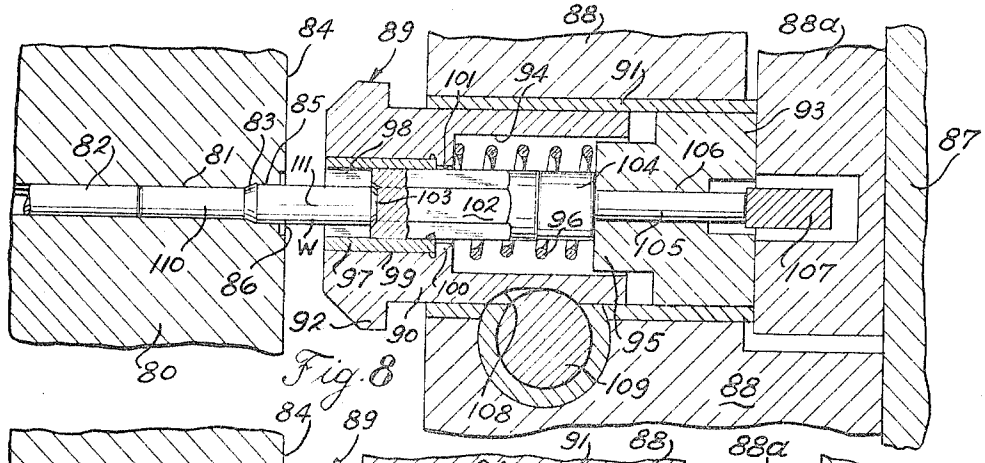


Fig. 8

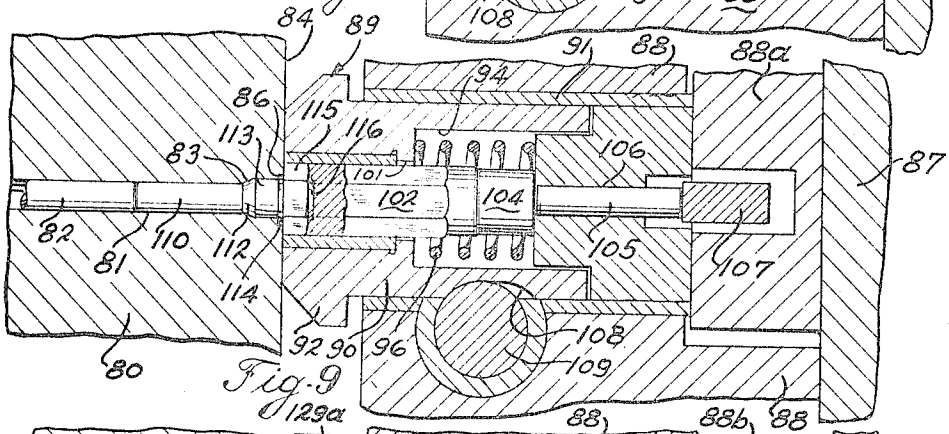


Fig. 9

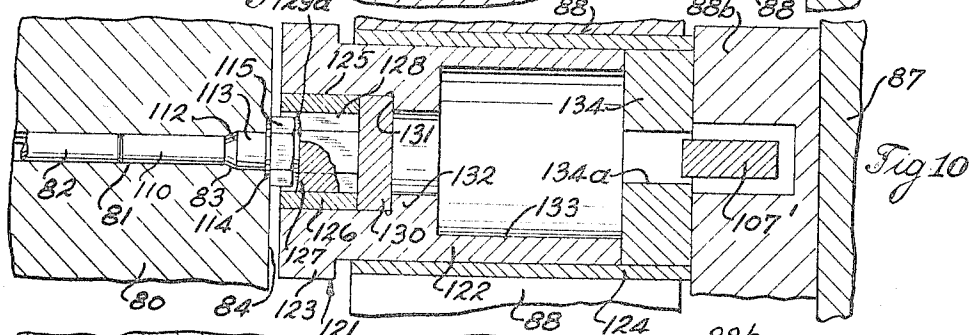


Fig 10

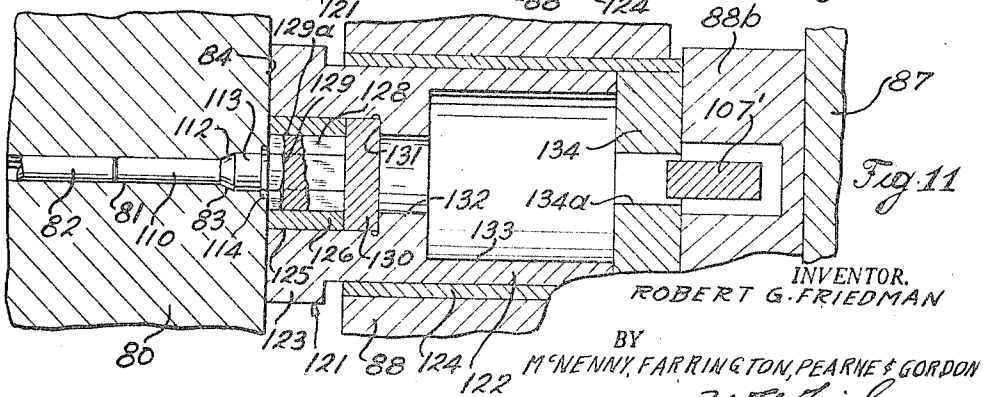


Fig. 11

INVENTOR.
ROBERT G. FRIEDMAN

BY
McNENNY, FARRINGTON, PEARNE & GORDON

ATTORNEYS

United States Patent Office 3,289,229 Patented Dec. 6, 1966

3,289,229

APPARATUS FOR COLD HEADING BLANKS

Robert G. Friedman, Tiffin, Ohio, assignor to The National Machinery Company, Tiffin, Ohio, a corporation of Ohio

Original application Sept. 21, 1960, Ser. No. 57,529. Divided and this application July 2, 1965, Ser. No. 469,246

13 Claims. (Cl. 10—12.5)

This invention relates to a novel and improved apparatus particularly suited for the cold heading of a blank for a bolt, screw, or the like, and is a division of my copending application, Serial No. 57,529, filed September 21, 1960 and now abandoned.

Forging or heading machines of the type known as double blow headers have been used to cold form various metal articles. Generally speaking, a double blow header comprises a die block through which round wire or rod stock is fed intermittently, a timed shearing mechanism for shearing off a predetermined length of the stock to provide a blank or workpiece, a transfer mechanism for positioning such blank in front of a forming die, and a header slide carrying two forming tools, a coning tool and a heading tool, which apply successive blows against the blank while the blank is held in the forming die. The header slide is reciprocated toward and away from the forming die, and the two heading tools are mounted on a shifting punch carrier which presents the tools alternately to the blank, so that first the coning tool strikes the blank to gather the stock and then the heading tool strikes the blank to finish the heading operation.

On such machines, two blows are used to permit forming a larger head than could be formed in a single blow, since if the length of stock necessary to provide the desired volume for the head were struck initially by the finish heading tool, the stock would buckle and bend instead of upsetting. Accordingly, the usual coning tool surrounds and confines the outer end of the stock and upsets against the die only a part of the protruding length of the blank, and the second tool then upsets the remaining length. While this permits gathering more stock and the making of the desired size head, it is accompanied by the disadvantage of a re-entrant folding of the metal between the two upsets, producing a weakened plane through the head. The greater the amount of upsetting in the first or coning blow, the greater the amount of reverse folding that occurs, and the weaker the finished head.

In the making of polygonal double-blow heads from ordinary round wire or rod stock, it has been necessary heretofore to upset the stock into an enlargement circular in cross-section with the desired axial length and a diameter slightly greater than the diameter across the corners of the desired finished head, and then cut away the peripheral portion with a polygonal trimming die. This involves a waste of the material trimmed from the head, and also aggravates the weakness from the re-entrant folding of the metal, since it is necessary to gather a volume of stock equal to the volume of the finished head plus the volume of the metal trimmed away.

According to the present invention, the entire length of stock necessary to provide the desired volume in the finished head is upset in each of two successive blows, first to a form similar to the desired finished head but of smaller cross-section and greater axial length, and second to the desired finished polygonal head without flash or waste.

By upsetting the entire protruding length of the stock in the first blow, flowing the metal only in the directions in which it must move to reach the finished shape, and again upsetting the entire volume in the second blow, flowing the metal farther, but only in the same directions

in which it moved in the first blow, a finished full-sized polygonal head may be produced without any re-entrant folding or flowing of the metal, without the necessity of a subsequent trimming operation, and without waste.

This operation has been made possible according to the present invention by surrounding the necessary unsupported length of stock, in the first blow of the header, by a polygonal enclosure similar to the desired polygonal shape of the finished head, but with a diameter across the flats of the polygonal enclosure only slightly greater than the diameter of the round wire stock so as to prevent the stock from buckling and bending, and then upsettting the stock axially into the polygonal enclosure. The resulting head portion, with an axial length small enough in proportion to its diameter across the flats to upset without buckling, the axial length preferably being not more than 2¼ times the diameter across the flats, is then upset in the second blow of the header into the desired finished form and dimension by a heading tool having a recess shaped to form the side faces and top face of the finished head.

It is an object of this invention to provide a novel and improved arrangement in a double blow header which enables the cold forming of a polygonal head on a round cross-section blank in just the two blows of the header.

Another object of this invention is to provide a novel arrangement for cold forming a polygonal head on round stock which avoids weakening of the head.

Another object of this invention is to provide a novel arrangement for cold forming a polygonal head on round stock which avoids waste of the stock material and which avoids the need for any subsequent trimming operations on the head.

Further objects and advantages of this invention will be apparent from the following detailed description of two presently preferred embodiments thereof, which are illustrated in the accompanying drawings.

In the drawings:

FIGURE 1 is a sectional view taken transversely through a double blow header which incorporates the present invention, showing the position of the parts during the first forward stroke of the header slide;

FIGURE 2 is a similar view showing the position of the parts later on in the first stroke of the header slide;

FIGURE 3 is a similar view showing the position of the parts at the end of the first forward stroke of the header slide;

FIGURE 4 is a similar view showing the position of the parts as the header slide is retracted following its first forward stroke;

FIGURE 5 is a similar view showing the position of the parts during the second forward stroke of the header slide, at which time the finish punch is positioned for operation against the blank;

FIGURE 6 is a similar view showing the position of the parts at the end of the second forward stroke of the header slide;

FIGURE 7 is a similar view showing the position of the parts when the header slide is retracted following its second forward stroke;

FIGURE 8 is a fragmentary transverse sectional view showing a second embodiment of the present apparatus, with the header slide moving forward in its first stroke;

FIGURE 9 is a similar view showing the position of the parts at the end of the first forward stroke of the header slide in FIGURE 8;

FIGURE 10 is a similar view showing the position of the parts during the second forward stroke of the header slide, at which time the finish punch is positioned to act on the blank;

FIGURE 11 is a similar view showing the position of

the parts at the end of the second forward stroke of the header slide; and

FIGURE 12 is an axial section of a cold-headed blank in accordance with this invention.

Referring first to the embodiment shown in FIGURES 1–7, the double blow header includes a single work-receiving die **20** formed with a cylindical bore or cavity. When it is desired to make a bolt with a washer face on the underside of the head, as in the illustrated embodiment, a cylindrical counterbore **22**, which is coaxial with the cavity **21**, is formed at the front face **23** of the die. A knock-out pin **24** is reciprocably mounted in the die at the back end of the cavity **21**. During the double blow heading operation on the workpiece or blank, this pin **24** remains stationary in the die so as to provide a fixed abutment for engagement by the inner end of the blank or workpiece.

The blank **25** is a predetermined length of round rod, which has been sheared from the wire or rod stock by the usual shearing mechanism (not shown) which is part of the double blow header apparatus. After having been sheared off from the rod stock, this blank **25** is positioned by the usual transfer mechanism (not shown) in front of the die cavity **21**.

Referring now to FIGURE 1, the double blow header includes the usual header slide **26** which is mounted for reciprocation toward and away from the die **20**. Shiftably mounted on the header slide is a tool carrier **27**, which in turn carries a cone tool and a finish tool for imparting the first and second blows against the blank. The tool carrier is adapted to be shifted to align the two tools alternately with the die cavity **21** during alternate reciprocations of the header slide **26**. Any suitable shifting mechanism may be used, preferably that shown in my U.S. Patent No. 3,031,698, issued May 1, 1962, or that shown in U.S. Patent No. 1,932,396 to Clouse.

The cone tool is designated in its entirety by the reference numeral **28** in FIGURE 1. It comprises a generally sleeve-like member **29** having an enlarged, cylindrical, tranverse flange **30** on its front end. The sleeve-like member **29** is slidably mounted in a bushing **31** carried by the tool holder **27**. A punch guide **32** is seated in the back end of the bushing **31** behind the back end of the sleeve member **29**. The punch guide **32** is stationary with respect to the tool holder **27** at all times. At its back end the sleeve member **29** of the cone tool is formed with a counterbore **33**. A coil spring **34** is received in this counterbore and is engaged under compression between the sleeve member **29** and the punch guide **32**, biasing the cone tool **28** forward with respect to the tool holder **27**.

At its front end the sleeve member **29** carries a punch die **35**. The punch die **35** is formed with a lengthwise cavity **36** which is hexagonal in cross-section. At its front end the punch die **35** presents a cylindrical nose **37** which projects beyond the front face of the flange **30** on the sleeve member **29** and which is shaped and dimensioned to be snugly, but slidably, received in the counterbore **22** in the die **20**.

A filler or back-up plate **38** is engaged between the back end of the punch die **35** and an internal transverse shoulder **39** formed in the sleeve member **29**.

The cone tool also includes a punch **40** which is hexagonal in cross-section and is arranged to be slidably, but snugly, received in the hexagonal cavity **36** in the punch die **35**. Approximately midway along its length the punch **40** is formed with an enlarged portion **41**, which is positioned to abut against the reduced front end **42** of the punch guide **32**. Behind this enlarged portion **41** the punch is formed with a reduced diameter cylindrical stem **43** which extends slidably through the punch guide **32**. A knock-out lever **44**, which is pivotally mounted on a part **27***a* of the tool holder **27**, is positioned to engage the back end of this stem **43**, as shown in FIGURE 1, when the cone tool **28** is aligned with the die cavity **21**.

The sleeve member **29** in the cone tool is formed with a lengthwise slot **45** in its periphery. A stop pin **46** carried by the tool holder **27** is engaged in this slot. The length of the slot **45** in a direction parallel to the direction of movement of the header slide is substantially longer than the corresponding length of the portion of the stop pin **46** which is received in this slot, so that the cone tool **28** is able to slide axially with respect to the tool holder **27** and the header slide **26** by an amount determined by these dimensions of the slot **45** and the stop pin **46**. Normally, as shown in FIGURE 1, the spring **34** biases the cone tool **28** forwardly with respect to the tool holder **27**.

FIGURE 1 shows the position of the parts during the first forward stroke of the header slide. The inner end of the blank **25** is snugly received in the work-receiving die **20** while its outer end is loosely received in the cavity **36** in the punch die. The outer, or right, end of the blank is engaged by the front end of the punch **40**, so that the blank is pushed into the die cavity **21** in response to the forward movement of the header slide **26** in its first stroke.

FIGURE 2 shows the position of the parts later on in the first forward stroke of the header slide, when the cone tool engages the front face **23** of the die **20**. At this time the nose **37** on the front end of the punch die **35** is snugly received in the counterbore **22** in the die **20**. The inner or left end of the blank **25** engages the knock-out pin **24** in the die **20**, while its opposite end is engaged by the front end of the punch **40**.

Upon continued forward movement of the header slide and the tool holder **27** the punch **40** is caused to move forward into the hexagonal cavity **36** in the punch die **35**. At this time the cone tool and the punch die **35** which it carries are held stationary by virtue of their engagement against the fixedly positioned die **20**. However, the tool holder **27** and the header slide **26** can continue to move forward by an amount determined by the length of the slot **45**. The spring **34** becomes compressed further during this over-travel of the tool holder **27** and the header slide **26** with respect to the cone tool **28**. The knock-out lever **44** remains stationary on the tool holder **27** throughout the first forward stroke of the header slide. During the completion of the forward stroke of the header slide (FIGURE 3), the punch **40** upsets the outer, or right, end of the blank **25** and cold forms the latter into a hexagonal cross-section segment **25***a* which tightly fills the hexagonal cavity **36** in the punch die **35**. In this operation, since the blank **25** is of round stock to begin with, the metal in the stock first upsets to a round and contacts tangentially the flat sides of the punch die cavity **36** which support the stock against buckling. Thereafter the metal in the stock fills in the corners of this die cavity. As a result, the die cavity is rather tightly packed at the end of the upsetting operation.

I have found that a critical factor in the operation which takes place during this first blow, as just described, is that the across-the-flats width of the die cavity **36** in the punch die **35** should not be greater than 1½ times, and preferably only 1¼ times the diameter of the initial blank **25**, when the volume of the head is such that a length of stock more than 2½ times the diameter must be upset. If this critical dimension is not exceeded, then the blank is restrained against buckling because of the support provided by the flats in the die cavity. Therefore, no re-entrant fold is formed in the upset portion of the blank and the blank proceeds to fill in the corners of the die cavity.

Thus, in the first, or coning, blow of the header the blank is upset into a head segment having the general polygonal shape of the desired finished head, but smaller in cross-section and longer axially. This initial upsetting of the blank from round cross-section into an enlarged

segment of the general polygonal shape desired makes possible the final upsetting which takes place in the second blow of the header.

At the completion of the first blow, the header slide **26** is retracted back away from the die **20**. During the initial retracting movement of the header slide **26** and the tool holder **27**, which moves in unison with it, the front end of the cone tool **28** remains in engagement with the front face **23** of the die **20** due to the urging of the spring **34**. However, when the tool holder **27** has retracted a distance determined by the slot **45**, the stop pin **46** again couples the cone tool **28** to the tool holder **27**, so that upon continued retraction of the header slide the cone tool **28** moves back away from the die **20**.

As the header slide starts its retracting motion from forward dead center, the knock-out lever **44** is actuated pivotally relative to the tool holder **27** such that the punch-engaging portion of this lever moves forward at substantially the same rate of speed as the header slide **26** and tool holder **27** are being retracted, so that the punch **40** remains substantially stationary against the end of the upset **25***a* until the cone tool **28** has been moved back and stripped from the upset **25***a*, as shown in FIGURE 4. This knock-out movement of the punch **40** is necessary to disengage the blank from the punch die **35** because of the fact that the hexagonal portion **25***a* of the blank fills the cavity in the punch die **35** quite snugly. Any suitable mechanism may be used for actuating the lever **44**, preferably the mechanism shown in my U.S. Patent No. 3,031,698, issued May 1, 1962, or U.S. Patent No. 2,271,257 to J. H. Friedman.

From FIGURE 4 it will be apparent that the blank remains seated in the die **20** during the retraction of the header slide after its first stroke.

Before the second forward stroke of the header slide, the tool carrier **27** is shifted on the header slide **26** so as to move the cone tool **28** out of alignment with the die **21** and move into alignment with the die **21** a finish punch tool **50** for engagement with the blank in the next forward stroke of the header slide, in the position shown in FIGURE 5. At the same time, the tool carrier **27** moves a knock-out lever **44'**, which is pivoted on a part **27***b* of the tool carrier **27**, to the position shown in FIGURE 5.

Referring now to FIGURE 5, the finish punch tool **50** includes a sleeve member **51** having an enlarged flange **52** on its front end. The sleeve member **51** is snugly received in a cylindrical bushing **49** carried by the tool carrier **27**.

A punch guide **53** is snugly received in the back end of the bushing **49**. At its front end the punch guide **53** is formed with a reduced diameter nose **54**. A rigid annular filler plate **55** is engaged between the front of the punch guide **53** and an internal, rearwardly-facing shoulder **56** formed on the finish punch **50**. With this arrangement, the finish punch **50** moves as a rigid unit with the header slide **26** and the tool carrier **27**.

At its front end the finish tool **50** carries a punch die **57** having a hexagonal die cavity **58** therein. The size of this die cavity **58** determines the size of the finished hex head on the blank. A knock-out pin **59** at its front end presents an enlarged, generally conical head **60** which is snugly, but slidably, disposed in the punch die cavity **58**. This head **60** is formed with spaced, forwardly projecting petals **61** at its periphery and a rearwardly curved edge between each pair of neighboring petals to form the rounded edges between the corners on the finished head on the blank.

A hexagonal back-up plate **62** is tightly received in the punch die **57** directly behind the head **60** on the knock-out pin **59**. This back-up plate is formed with a central, axial bore **63** which slidably receives the shank of the knock-out pin **59**. The back-up plate **62** also presents a forwardly facing conical surface **64** which is snugly complementary to the conical back end of the head **60** on the knock-out pin.

Just forward of its rearwardly-facing internal shoulder **56** the sleeve member **51** of the finish punch has a radially inwardly protruding segment **71** formed with a plurality of lengthwise holes **65** and an axial bore **66** which slidably receives the shank of the knock-out pin **59**. An annular plate, which slidably receives the shank of the knock-out pin **59**, is engaged between the front end of this radially inwardly protruding portion **71** of the sleeve member **51** and the back end of the punch die **57** and the back-up plate **62** therein.

At the back end of the knock-out pin **59** a larger diameter pin **68** is snugly, but slidably, receives in an axial bore **69** in the guide plate **53**. The length of the pin **68** is equal to the axial length of the guide plate **53**. The back end of this pin **68** is engaged by the knock-out lever **44'**, which is pivotally mounted on the tool carrier **27**. The front end of the pin **68** engages the back face of a sleeve **72**, which is slidably mounted in the annular plate **55**. From FIGURE 5 it will be apparent that the axial length of the sleeve **72** is substantially less than the axial length of the plate **55**, so that the sleeve **72** is able to slide axially a predetermined distance within the plate **55**. This happens when the pin **68** is moved forward by the knock-out lever **44'**, as described in detail hereinafter.

FIGURE 5 shows the position of the parts during the first portion of the forward movement of the header slide **26** in its second stroke. The finish punch **50** and the tool carrier **27** move forward in unison with the header slide **26** at this time.

When the enlarged head **60** on the knock-out pin **59** engages the outer end face of the hexagonal, upset portion **25***a* on the blank **25**, during the continued forward movement of the header slide, it causes the hexagonal portion **25***a* to be upset further to the final hex head shape **25***c* shown in FIGURE 6. This upsetting action takes place completely within the punch die cavity **58** and the cylindrical counterbore **22** in the die **20**. As a result of this action, a cylindrical collar **25***b* is formed on the blank just forward of the finished hexagonal head **25***c*.

I have found that a critical factor in the successful operation of this embodiment of the present invention is that the axial length of the hexagonal segment **25***a*, which is to be upset in the second blow of the header, should not be more than 2¼ times the across-the-flats dimension of the finished hex head **25***c*. This prevents buckling of the stock as it is being upset to its final shape, which is appreciably shorter axially and larger in cross-section.

During the upsetting of the metal in the second blow of the header, the conical front end face **64** of the back-up plate **62**, which fits tightly in the punch die **57**, supports the enlarged head **60** on the knock-out pin, particularly at the petals **61** thereon which form the chamfer on the corners of the head on the blank. Because of this, the head **60** on the knock-out pin is sealed around its entire periphery and no flash can form.

In both upsetting blows the blank has no tendency to buckle and the upsetting action proceeds in the desired manner, completely avoiding the formation of a re-entrant fold in the upset head. Also, in both blows the upset metal flows in the same direction, the flow which takes place in the second blow being essentially an extension of the flow which occurred in the first blow. The end result is that the head is completely finished in just two blows and has improved strength.

At the completion of the second blow the header slide **26** is again retracted, carrying with it the tool carrier **27** and the finish punch **50**. At this time the knock-out lever **44'** is operated in its forward stroke to push the pin **68** forward. The pin **68** engages the sleeve **72** and the knock-out pin **59** and forces them forward until the sleeve **72** strikes the radially inwardly protruding mid-portion **71** of the sleeve member **51**. This limits

the extent to which the knock-out pin 59 can move forward with respect to the finish punch 50. During this movement of the knock-out pin 59 its head 60 pushes the finished hex head 25c on the blank out of the punch die cavity 58 and maintains the blank seated in the cavity 21 in the fixed die 20.

After the header slide 26 has been retracted a sufficient amount, the knock-out pin 24 in the fixed die 20 is actuated forward to knock the finished blank out of the die cavity 21 therein.

Following this, and before the next forward stroke of the header slide 26, another length of the wire stock is sheared off and is moved into position in front of the die cavity 21, so that in the next forward stroke of the header slide this next blank is upset in the manner shown in FIGURES 1–4.

The headed blank produced by the just-described apparatus and process is suitable as a cap screw whose shank 25 may be threaded up to the finished hex head.

This particular embodiment is particularly suitable where the cross-sectional size of the finished head is to be rather large compared to the original diameter of the blank.

In one suitable practical embodiment of this form of the invention the starting blank is of .270 inch diameter wire, the upset hex head segment 25a after the first blow has an across-the-flats width of about .315 inch and the finished hex head 25c (after the second blow) has an across-the-flats width of about .495 inch and an axial length of about .193 inch.

When it is desired to make a bolt with a shank portion adjacent the head having a diameter equal to the over-all diameter of the threads to be formed on the remainder of the shank, it is possible to simplify the apparatus and perform more of the upsetting in the first blow, because larger diameter stock may be used so that a shorter length supplies the necessary volume for the finished head. This is illustrated in the second embodiment of the present invention, shown in FIGURES 8–11. The fixed die in the header frame is designated in its entirety by the reference numeral 80. This die is formed with a cylindrical bore 81 which slidably receives a knock-out pin 82. At its forward end the bore 81 leads into a short frusto-conical bore section 83 which is of increasing diameter toward the front of the fixed die, constituting an extrusion throat. At its front end the frusto-conical bore section 83 leads into a cylindrical bore section 85 of larger diameter than the bore 81. A cylindrical counterbore 86 is formed in the front end face 84 of the fixed die when it is desired to form a washer face on the underside of the head.

Prior to the first stroke of the header slide in the apparatus of FIGURE 8, a blank of round bar or wire stock is positioned in front of the cavity 86, 85, 83, 81 in the fixed die 80 in the same manner as in the first embodiment.

The header slide 87 carries a shiftable tool holder 88 which, in turn, carries a cone tool designated in its entirety by the reference numeral 89, shown in alignment with the die in FIGURES 8 and 9. The cone tool comprises a sleeve member 90 which is slidably received in a cylindrical bushing 91 carried by the tool holder 88. At the front end the sleeve member has an enlarged transverse flange 92.

A punch guide 93 is seated in the back end of the bushing 91 behind the back end of the sleeve member 90. This punch guide is stationary with respect to the tool holder 88 at all times.

At its back end the sleeve member 90 of the cone tool is formed with a counterbore 94 which loosely receives the reduced diameter front end 95 of the punch guide 93. A coil spring 96 is received in this counterbore and is engaged under compression between the sleeve member 90 and the punch guide 93, biasing the cone tool 89 forward with respect to the tool holder 88.

At its front end the sleeve member 90 carries a punch die 97. The punch die is formed with a lengthwise cavity 98 which is hexagonal in cross-section. The front end of the punch die 97 is flush with the front end face of the sleeve member 90. The punch die 97 is snugly seated in a complementary recess 99 formed in the sleeve member 90. Between its recess 99 at its front end and its counterbore 94 at its back end the sleeve member 90 presents a radialy inwardly protruding, anular portion 100 which extends around an axial opening 101 which joins the cavity 99 to the counterbore 94.

The cone tool also includes a punch 102 which is hexagonal in cross-section and which is arranged to be slidably, but snuggly, received in the hexagonal cavity 98 in the punch die 97. As shown in FIGURE 8, the hexagonal front end of the punch extends loosely through the opening 101 and into the cavity in the punch die 97. At its front end the punch may be formed with a shallow recess 103, for a purpose which will be explained hereinafter.

Approximately midway along its length the punch 102 presents a cylindrical portion 104, and behind that a reduced diameter cylindrical stem 105. The back end of the punch portion 104 is disposed just in front of the reduced diameter front end 95 of the punch guide 93. The smaller diameter stem 105 on the punch is snugly, but slidably, received in an axial bore 106 in the punch guide 93, so that the punch is guided by the punch guide 93. A knock-out lever 107, which is pivotally mounted a part 88a of tool holder 88, is positioned to engage the back end of the punch stem 105, as shown in FIGURE 8, when the cone tool is in alignment with the die.

The sleeve member 90 in the cone tool is formed with a short lengthwise slot 108 in its periphery. A transversely disposed stop pin 109 carried by the tool holder 88 is engaged in this slot. The axial length of this slot determines the distance which the tool holder 88 can move with respect to the cone tool 89, as in the first embodiment of this invention. Normally, as shown in FIGURE 8, the spring 96 biases the cone tool 89 forwardly with respect to the tool holder 88 so that the stop pin 109 engages the back end of the slot 108 in the cone tool.

In this embodiment of the present invention the blank which is cut from round rod stock initially has a diameter substantially equal to that of the cylindrical bore section 85 in the fixed die 80.

Prior to the first forward stroke of the header slide 87, this workpiece W is positioned in front of the cavity in die 80.

As the header slide 87 moves forward in its first stroke, it carries with it the cone tool 89. The punch die 97 moves forward, loosely surrounding the outer, or right, end of the blank W. When the punch 102 carried by the header slide 87 engages the outer end face of the blank W, it begins to slide the blank into the cavity in die 80. The inner end 110 of the blank W is extruded through the extrusion throat 83 of the fixed die cavity and extends into the smaller diameter cylindrical portion 81 of the fixed die cavity. This action continues during the continued forward movement of the header slide 87, until the front end of the workpiece W engages the now fixedly positioned knock-out pin 82 in the die 80. The condition of the parts at this time is shown in FIGURE 8.

As the header slide 87 continues to move forward, carrying with it the cone tool 89, the outer end portion 111 of the workpiece W is upset so as to fill the hexagonal cavity 98 in the punch die 97 and also to fill the cylindrical counterbore 86 in the front end of the fixed die 80. When the unsupported length 111 of the blank approaches or exceeds slightly the critical limits of this embodiment, it is preferable to include the recess 103 in the front end of the punch 102, so that the portion 111 of the workpiece which is being upset is supported from both ends.

In this upsetting operation, since the blank W is of

round stock to begin with, the metal first upsets to a round and contacts tangentially the flat sides of the punch die cavity **98**, and thereafter the metal fills the corners of this die cavity and tightly packs this die cavity.

In this second embodiment of the present invention, I have found that a critical factor in its operation during the first blow of the double blow header is that the across-the-flats width of the hexagonal cavity **98** in the punch die should be not greater than 1½ time the diameter of the initial blank W. As in the first-described embodiment, the blank is restrained against buckling because of the support provided by the flats in the punch die cavity, so that the upsetting action can continue until the corners in the die cavity are filled.

When the necessary volume to form the finished head can be obtained from an unsupported length of stock not more than 2½ times the diameter, and the cavity **98** has a width across-the-flats of no more than 1½ times the stock diameter, the metal upsets successfully without folding. However, when the dimensions approach or slightly exceed these limts, perfect upsets can still be obtained by using the recess **103**.

The front end of the sleeve member **90** in the cone tool engages the front end face **84** of the fixed die **80** before the header slide **87** has completed its first forward stroke, and before the stock **111** has bulged far enough to contact the flats of the cavity **98**. Therefore, upon the continued forward movement of the header slide **87** toward the end of its stroke, the spring **96** becomes compressed further, as shown in FIGURE 9. Also, since the punch **102** is moving in unison with the header slide **87** at this time, the punch moves forward in the punch die cavity **98** to complete the upsetting of the outer end **111** of the workpiece W. This over-travel of the header slide **87** and the punch **102** with respect to the sleeve member **90** is made possible by the lost motion connection provided by the stop pin **109** and the slot **108** in the sleeve member **90**.

At the completion of the first forward stroke of the header slide **87**, the parts are in the position shown in FIGURE 9. From this figure, it will be apparent that the workpiece W has been cold formed to provide a reduced diameter, round cross-section segment **110** at its inner end, a short, gradually increasing diameter section **112** just forward of the reduced diameter inner end **110**, a somewhat longer cylindrical segment **113** joined to the front end of the segment **112**, a short, enlarged cylindrical collar **114** seated in the counterbore **86** in the front end of the fixed die, and enlarged hexagonal head segment **115** in the punch die cavity **98**, and a rounded, forwardly protruding segment **116** on the outer end face of the hexagonal head segment **115**. This protruding segment **116** conforms snugly to the shape of the recess **103** in the front end of the punch **102**, while the hexagonal head segment **115** conforms snugly to the punch die cavity **98** and the cylindrical collar **114** conforms snugly to the counterbore **86** in the front end of the fixed die **80**.

As the reciprocatory header slide **87** is retracted following its first forward stroke, the spring **96** holds the sleeve member **90** of the cone tool forward against the front end face **84** of the fixed die **80** during the initial rearward movement of the header slide. After lost motion movement of the header slide **87** rearward with respect to the sleeve member **90**, as determined by the length of the slot **108**, the sleeve member **90** then begins to move rearward away from the fixed die **80**. At this time the knock-out lever **107** operates in its forward stroke to force the punch **102** forwardly with respect to the sleeve member **90**. This forward movement of the punch **102** ejects the just-formed hexagonal head portion **115** on the workpiece from the punch die **97** and holds the remainder of the workpiece seated in the cavity in the fixed die **80**. Thereafter, the punch **102** retracts away from the workpiece, along with the header slide **87** and the sleeve member **90**.

Before the second forward stroke of the header slide **87**, the tool carrier **88** is shifted to move the cone tool **89** out of alignment with the blank and move the finish punch tool into position for engagement with the blank in the next forward stroke of the header slide. At the same time, the tool carrier **88** positions a knock-out lever **107'**, which is pivoted on a part **88*b*** of the tool carrier, to the position shown in FIGURE 10.

Referring now to FIGURE 10, the tool carrier **88** carries the finish punch, designated in its entirety by the reference numeral **121**. The finish punch tool includes a sleeve member **122** having an enlarged flange **123** on its front end. The sleeve member **122** is snugly received in a cylindrical bushing **124** carried by the tool holder **88**.

At its front end the sleeve member **122** is formed with a cavity **125** in which is seated a punch die **126**. The front end of the punch die defines a hexagonal cavity **127** corresponding in size to the finished head on the blank. A fixed hexagonal punch **128** is seated in the punch die presenting a front face **129** with a curvature complementary to the desired curvature of the end of the finished head on the blank. At its corners the punch presents forwardly protruding petals **129*a*** which snugly fill the corners of the punch die cavity to prevent flashing of the blank material and also to produce the beveled corners on the outer end of the finished head.

A rigid back-up plate **130** engages the back ends of the punch die **126** and the punch **128**. The sleeve member **122** presents an inwardly protruding shoulder **121** at the back end of cavity **125**, against which the plate **130** is seated. Behind this shoulder the sleeve member **122** has a bore **132** which leads into an enlarged counterbore **133**. A plate **134** is received in the back end of the bushing **125**, engaging the back end of sleeve member **122**. Plate **134** is formed with a passage **134*a*** which permits the forward movement of the knock-out lever **107'**.

During the second forward stroke of the header slide **87**, the front end of the punch member **128** in the punch die **126** engages the protruding dimple **116** on the outer end of the hex head **115** and the front end of the punch die **126** surrounds the outer end of this hex head. As the header slide continues to move forward the dimple **116** is flattened into the hex head segment and the hex head segment itself is further upset to fill the punch die cavity **127**. At the end of the second forward stroke of the header slide the front end **123** of the sleeve member **122** is engaging the front face **84** of the fixed die and the hex head on the workpiece is squeezed between the front face **84** of the fixed die **80**, the side walls of the punch die cavity **127**, and the rounded front end face **129** of the plug **128** in the punch die cavity.

Thereafter, the header slide **87** is retracted again, carrying with it the entire finish punch **121**, which leaves the blank W seated in the fixed die **80**. The knockout lever **107'** is actuated at this time, but is ineffective. Its action is not necessary to maintain the blank seated in the fixed die **80**. Then the knock-out pin **82** in the fixed die **80** is actuated forward to knock the finished blank W out of the die cavity.

Following this, and before the next forward stroke of the header slide **86**, another length of wire stock is sheared off and is moved into position in front of the cavity in the fixed die **80**, so that in the next forward stroke of the header slide this next blank is upset in the manner shown in FIGURES 8 and 9.

This second embodiment of the invention is particularly suitable where the finished hex head is to have a cross-sectional size which is not particularly large compared to the original diameter of the blank. In such situations it is possible to upset the blank in the first blow almost to its final size, which is what takes place in the arrangement shown in FIGURES 8–11.

In one practical embodiment of the second form of the invention, the starting blank is a length of .305 inch diameter wire stock, the across-the-flats width of the up-

set head segment 115 after the first blow is about .460 inch, and the finished hex head has an across-the-flats width of about .495 inch and an axial length of about .193 inch.

It will be evident that the second embodiment operates upon essentially the same novel principles as the first, with the blank being upset in the first blow from round cross-section to the general polygonal shape desired in the finished head, while in the second blow the blank is further upset to the final shape, with the metal flowing in the same direction as in the first blow, but farther, in order to complete the cold formation of the head.

In both embodiments the amount of blank material required to make up the finished head is less than if the blank where upset to an enlarged round cross-section and then trimmed to the desired polygonal shape. For this reason, the present invention enables the unsupported length of the blank in the first blow to be shorter, which reduces the likelihood of buckling of this portion of the blank while it is being upset.

The finished blank has superior properties, the polygonal head being quite strong because of the absence of the re-entrant fold produced by the techniques common in the prior art. The finished head on the blank has flow lines throughout which are characteristic of the progressive upsetting of the blank twice in the same direction.

FIGURE 12 illustrates an axial section of a finished bolt blank in accordance with the present invention. The dotted lines in the blank illustrated there represent the flow lines in the blank, as revealed by etching the blank half along the axial section face where the blank was cut in two. The blank was produced by the foregoing apparatus and method. As shown in this figure, the flow lines in the shank or stem portion of this blank are straight and run lengthwise of the blank. In the upset head portion of the blank, the flow lines are curved in the same general direction as the head was upset. Near the axis of the blank the curvature of the flow lines is slight. The flow lines toward the radially outward edge of the head are progressively more curved in a gradual manner. Throughout the blank, and particularly in the head, there are no flow lines which would tend to weaken the blank appreciably.

While two presently-preferred embodiments of the apparatus and method of the present invention have been described herein, with reference to the accompanying drawings, it is to be understood that various modifications, omissions and refinements which depart from the disclosed embodiments may be adopted without departing from the spirit and scope of this invention. For example, the finished head may be square or any other polygonal shape other than hexagonal.

I claim:

1. A double blow header comprising a work-receiving die adapted to receive an elongated blank with one end protruding therefrom, first and second tools operable to successively upset the protruding end of said blank to form a polygonal head thereon, said first tool including a sleeve formed with a uniform cross-section passage therein, and a polygonal cross-section punch closely fitting in said passage, mounting means mounting said sleeve for axial movement relative to said punch between the forward position toward said die and rearward positions spaced back from said forward position, means maintaining said sleeve in said forward position as said first tool moves toward said die until the end of said sleeve engages the end of said die, said sleeve and die cooperating to define a polygonal die cavity closed at the end face of said die before said punch completes its upsetting operation, said sleeve and die being fixed against relative movement and completely confining said protuding end during at least the final portion of upsetting by said first tool, said second tool being formed with a uniform cross-section polygonal die cavity having side and end walls fixed against relative movement during its entire upsetting operation on said protruding portion, the cross-section of said polygonal die cavity in said second tool being greater than the cross-section of said passage in said sleeve.

2. A double blow header comprising a work-receiving die adapted to receive an elongated blank with one end protruding therefrom, first and second tools operable to successively upset the protruding end of said blank to form a polygonal head thereon, said first tool including a sleeve formed with a uniform cross-section passage therein, and a polygonal cross-section punch closely fitting in said passage, the end of said punch being formed with a shallow recess proportioned to laterally support said protruding end, mounting means mounting said sleeve for axial movement relative to said punch between the forward position toward said die and rearward positions spaced back from said forward position, resilient meaus maintaining said sleeve in said forward position as said first tool moves toward said die until the end face of said sleeve engages the end face of said die, said sleeve and die cooperating to define a polygonal die cavity closed at the end face of said die before said punch completes its upsetting operation, said sleeve and die being fixed against relative movement and completely confining said protruding end during at least the final portion of upsetting by said first tool, said second tool being formed with a uniform cross-section polygonal die cavity having side and end walls fixed against relative movement during its entire upsetting operation on said protruding portion, the cross-section of said polygonal die cavity in said second tool being greater than the cross-section of said passage in said sleeve.

3. In a double blow header which includes a work-receiving die having a cavity for snugly receiving and holding a round cross-section blank, a header slide movable toward and away from said work-receiving die, and first and second forming tools carried by said header slide for engagement alternately with a blank in the work-receiving die in successive strokes of the header slide, the improvement which comprises the first of said forming tools being a cone tool including a first punch die with a uniform cross-section polygonal die cavity facing toward said work-receiving die which is larger in cross-section than the cavity in the work-receiving die, said die cavity in the first punch die having a cross-sectional size and an axial depth sufficient to accommodate a volume of blank material substantially equal to that required for the finished polygonal head on the blank, said first punch die being yieldably mounted on said header slide to project toward said work-receiving die and to engage said work-receiving die prior to the completion of the forward movement of the header slide in its first stroke, means providing a lost-motion coupling between the first punch die and the header slide which limits the relative movement between them, and a cone punch extending snugly into said punch die cavity and mounted on said header slide to move as a rigid unit therewith throughout the forward movement of the header slide in its first stroke for engagement with the blank to upset the blank during the completion of the forward movement of the header slide following the engagement of the first punch die against the work-receiving die, and means for moving the cone punch forward with respect to the first punch die as the header slide is retracted after its first stroke so as to strip the upset blank from the first punch die and hold the blank seated in the work-receiving die, and the second of said forming tools being a finish punch tool including a second punch die with a polygonal die cavity facing toward said work-receiving die which is larger in cross-section and of shorter depth axially than the die cavity in said first punch die, and a finish punch having an enlarged head in said second punch die, said head on said finish punch having a polygonal front end which is received snugly in said second punch die at the inner end of the polygonal cavity therein, said polygonal front end of the finish punch head presenting a rounded end face which faces forward into the die cavity in said second

punch die and having forwardly projecting petals snugly received in the corners of the die cavity in said second punch die, said head on the finish punch behind its front end face having a back end which tapers rearwardly and laterally inwardly, rigid backing means engaging and supporting said tapered back end of the head on the finish punch completely across the latter's width, and said finish punch having a stem connected to and extending rearwardly from its tapered back end, said stem extending slidably through said rigid backing means, said finish punch being mounted on said header slide to move as a rigid unit therewith throughout the forward movement of the header slide in its first stroke so as to further upset the blank against the walls of said second punch die cavity, and means for moving said finish punch forward with respect to the second punch die as the header slide is retracted after its second stroke so as to strip the upset blank from the second punch die and hold the blank seated in the work-receiving die.

4. In a double blow header which includes a work-receiving die having a cavity for snugly receiving and holding a round cross-section blank, a header slide movable toward and away from said work-receiving die, and first and second forming tools carried by said header slide for engagement alternately with a blank in the work-receiving die in successive strokes of the header slide, the improvement which comprises the first of said forming tools being a cone tool including a first punch die with a polygonal die cavity facing toward said work-receiving die which is larger in cross-section than the cavity in the work-receiving die, said die cavity in the first punch die having a cross-sectional size and an axial depth sufficient to accommodate a volume of blank material substantially equal to that required for the finished polygonal head on the blank, said first punch die being yieldably mounted on said header slide to project toward said work-receiving die and to engage said work-receiving die prior to the completion of the forward movement of the header slide in its first stroke, means providing a lost-motion coupling between the first punch die and the header slide which limits the relative movement between them, and a cone punch extending snugly into said punch die cavity and mounted on said header slide to move as a rigid unit therewith throughout the forward movement of the header slide in its first stroke for engagement of the first punch die against the blank during the completion of the forward movement of the header slide following the engagement of the first punch die against the work-receiving die, said first punch having a recess in its end face in said punch for holding the end of the blank, and means for moving the cone punch forward with respect to the first punch die as the header slide is retracted after its first stroke so as to strip the upset blank from the first punch die and hold the blank seated in the work-receiving die, and the second of said forming tools being a finish punch tool including a second punch die with a polygonal die cavity facing toward said work-receiving die which is larger in cross-section and of shorter depth axially than the die cavity in said first punch die, and a polygonal finish punch seated in said second punch die, said finish punch having a polygonal front end which is received snugly in said second punch die at the inner end of the polygonal cavity therein, said polygonal front end of the finish punch presenting a rounded end face which faces into the die cavity in said second punch die and having forwardly projecting petals snugly received in the corners of the die cavity in said second punch die, rigid backing means engaging the back end of the finish punch completely across the latter's width, said finish punch being mounted on said header slide to move as a rigid unit therewith throughout the forward movement of the header slide in its first stroke so as to further upset the blank against the walls of said second punch die cavity.

5. In a double blow header, the improvement which comprises a finish punch tool including a punch die having a polygonal die cavity therein, a punch having an enlarged head in said die, said head on the punch having a polygonal front end which is received snugly in the punch die at the inner end of the polygonal cavity therein, said polygonal front end of the punch head presenting a rounded end face which faces forward into the die cavity and having forwardly projecting petals snugly received in the corners of the die cavity, said head on the punch behind its front end face having a back end which tapers rearwardly and laterally inwardly, and rigid backing means engaging and supporting said tapered back end of the head on the punch completely across the latter's width.

6. The apparatus of claim 5 wherein said punch has a stem connected to and extending rearwardly from the tapered back end of said head, said stem extending slidably through said rigid backing means, and wherein there is provided means for moving said punch forward into said punch die cavity.

7. A tool for forging polygonal head bolt blanks comprising an assembly formed with a uniform cross-section die cavity having side walls and a concave end wall extending inwardly therefrom to an axial bore, and a tool having a stem portion extending through said bore and an enlarged portion, said enlarged portion having a rearwardly facing surface proportioned to closely fit said concave end wall and a forwardly facing surface having forwardly projecting petals adjacent the corners of said side walls, the enlarged portion of said tool being supported against axial and radial forces by said concave end wall and being free for movement relative to said die assembly in a direction away from said concave end wall.

8. A die for forging polygonal head bolt blanks comprising an assembly formed with a uniform cross-section die cavity having side walls and a conical end wall extending inwardly therefrom to an axial bore, and a tool having a stem portion extending through said bore and an enlarged portion, said enlarged portion having a rearwardly facing conical surface proportioned to closely fit said conical end wall and a forwardly facing surface having forwardly projecting petals adjacent the corners of said side walls, the enlarged portion of said tool being supported against axial and radial forces by said conical end wall and being free for movement relative to said die assembly in a direction away from said conical end wall.

9. A die assembly for forming polygonal headed bolt blanks from cylindrical stock comprising a die having an extrusion throat proportioned to reduce the diameter of a portion of said stock, a first tool assembly defining a uniform cross-section polygonal cavity having an end wall formed with a shallow guide recess proportioned to laterally support one end of the stock as the other end is pressed through said throat during a first portion of the working stroke of said first tool assembly, backup means preventing stock movement through said throat when a predetermined amount of stock is passed therethrough so that a portion of stock is upset to an intermediate head substantially filling said polygonal die cavity during the final portion of the working stroke of said first tool assembly, and a second tool assembly formed with a uniform cross-section die cavity with side walls and an end wall of the shape of the finished head, said end wall of said second die assembly pressing the projection formed by said recess into the upset head forming a smooth end on the finished blank.

10. A die assembly for forming polygonal headed bolt blanks from cylindrical stock comprising a die having an extrusion throat proportioned to reduce the diameter of a portion of said stock, a first tool assembly defining a uniform cross-section polygonal cavity having an end wall formed with a shallow guide recess proportioned to laterally support one end of the stock as the other end is pressed through said throat during a first portion of the working stroke of said first tool assembly, backup means preventing stock movement through said throat when a predetermined amount of stock is passed therethrough so that a portion of stock is upset to an intermediate

head substantially filling said polygonal die cavity during the final portion of the working stroke of said first tool assembly, and a second tool assembly for subsequently working said intermediate head while said blank remains in said die, said second tool assembly being formed with a uniform cross-section die cavity with side walls and an end wall of the shape of the finished head, said end wall of said second die assembly pressing the projection formed by said recess into the upset head forming a smooth end on the finished blank.

11. In a double blow header which includes a work-receiving die having a cavity for snugly receiving and holding a round cross section blank, a header slide movable toward and away from said work-receiving die, and first and second forming tools carried by said header slide for engagement alternately with a blank in said work-receiving die on successive strokes of the header slide, the improvement which comprises the first of said forming tools being a cone tool including a first punch die with a polygonal die cavity of substantially uniform cross section facing toward said work-receiving die which is larger in cross-section than the cavity in the work-receiving die, said die cavity in said first punch die having a cross sectional size and an axial depth sufficient to accommodate a volume of blank material substantially equal to that required for the finished polygonal head of the blank, and a first punch extending snugly into said punch die cavity for engagement with the blank to upset the blank against the walls of said punch die cavity in the first stroke of the header slide, and the second of said forming tools being a finished punch tool including a second punch die with a polygonal die cavity of substantially uniform cross section facing toward said work-receiving die which is larger in cross section and shorter in depth axially than the die cavity in said first punch die, and a finish punch in said second punch die cavity for engagement with the blank to further upset the blank against the walls of said second punch die cavity in the next stroke of said header slide, said first punch die being yieldably mounted on said header slide to project toward said work-receiving die and to engage said work-receiving die prior to the completion of the forward movement of the header slide in its first stroke, and said first punch being mounted on said header slide to move as a rigid unit therewith throughout the forward movement of the header slide in its first stroke so as to upset the blank during the completion of the forward movement of the header slide following the engagement of the first punch die against the work-receiving die, and a lost motion coupling between the first punch die and the header slide which limits the relative movement between them.

12. In a double blow header which includes a work-receiving die having a cavity for snugly receiving and holding a round cross section blank, a header slide movable toward and away from said work-receiving die, and first and second forming tools carried by said header slide for engagement alternately with a blank in said work-receiving die on successive strokes of the header slide, the improvement which comprises the first of said forming tools being a cone tool including a first punch die with a polygonal die cavity of substantially uniform cross section facing toward said work-receiving die which is larger in cross section than the cavity in the work-receiving die, said die cavity in said first punch die having a cross sectional size and an axial depth sufficient to accommodate a volume of blank material substantially equal to that required for the finished polygonal head of the blank, and a first punch extending snugly into said punch die cavity for engagement with the blank to upset the blank against the walls of said punch die cavity in the first stroke of the header slide, and the second of said forming tools being a finished punch tool including a second punch die with a polygonal die cavity of substantially uniform cross section facing toward said work-receiving die which is larger in cross section and shorter in depth axially than the die cavity in said first punch die, and a finish punch in said second punch die cavity for engagement with the blank to further upset the blank against the walls of said second punch die cavity in the next stroke of said header slide, said first punch die being yieldably mounted on said header slide to project toward said work-receiving die and to engage said work-receiving die prior to the completion of the forward movement of the header slide in its first stroke, and said first punch being mounted on said header slide to move as a rigid unit therewith throughout the forward movement of the header slide in its first stroke so as to upset the blank during the completion of the forward movement of the header slide following the engagement of the first punch die against the work-receiving die, and means are provided for moving the first punch forward with respect to the first punch die as the header slide is retracted after its first stroke so as to strip the blank from the first punch die and hold the blank seated in the work-receiving die.

13. A die assembly for forming polygonal headed bolt blanks from cylindrical stock comprising a die proportioned to receive and support said stock with a free end portion projecting beyond the face of such die, a first tool assembly defining a uniform cross section polygonal cavity having an end wall formed with a shallow guide recess proportioned to laterally support the end of said free end portion of said stock to prevent buckling, said free end portion being upset to an intermediate head substantially filling said polygonal die cavity during the final portion of the working stroke of said first tool assembly, and a second tool assembly formed with a uniform cross section die cavity with side walls and and end wall of the shape of the finished head, said end wall of said second die assembly pressing the projection formed by said recess into the upset head forming a smooth end on the finished blank.

References Cited by the Examiner

UNITED STATES PATENTS

1,026,082	5/1912	Duston	10—26
1,168,855	1/1916	Blakeslee	10—26
1,617,122	2/1927	Kaufman	10—27
1,778,562	10/1930	Noble	10—27
2,202,324	5/1940	Tomalis	10—27 X
2,586,336	2/1952	Huck	10—27

OTHER REFERENCES

Linsley, H. E.; American Machinist, April 8, 1948, pp. 99–110 relied on.

ANDREW R. JUHASZ, *Primary Examiner.*