# United States Patent [19]

**Steffan**

[11] **3,783,462**

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[54] **CONCRETE FORM SNAP-TIE ROD AND METHOD OF FORMING THE HEAD THEREFOR**


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[21] Appl. No.: **153,979**

[52] **U.S. Cl.** ..... **10/27 H,** 85/9 R, 85/45, 219/152

[51] **Int. Cl.** ..... **B21k 1/46**

[58] **Field of Search** ..... 10/11, 12, 15, 24, 10/27, 27 H; 85/9 R, 45; 219/7.5, 149, 150 R, 150 V, 151, 152; 249/42, 43, 46, 213, 214, 216



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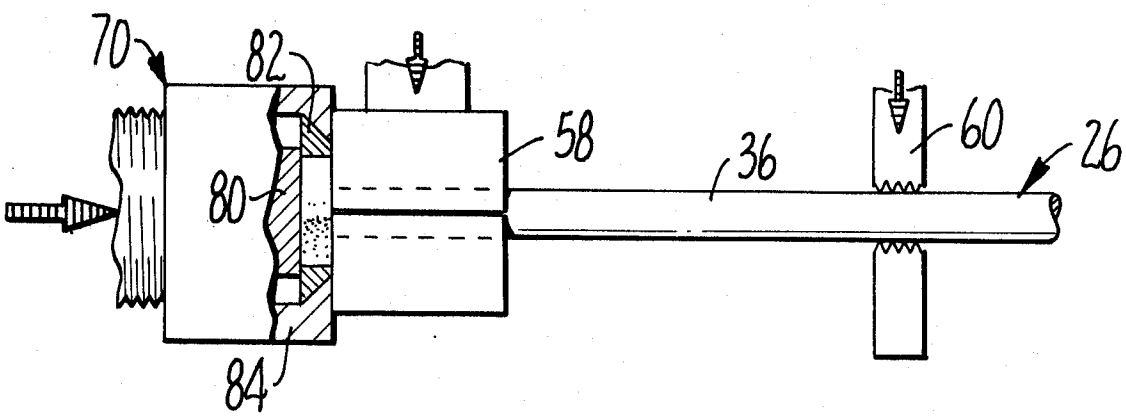
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[57] **ABSTRACT**

A snap-tie rod having a hot-upset end with other than a round periphery so that the end may be gripped with a socket-type wrench. The head of the rod is fabricated by a hot-upsetting method wherein the periphery of the head is confined within a flat-sided peripheral die during upsetting so that the periphery of the head is formed with flat sides conforming to the die.


**3 Claims, 11 Drawing Figures**



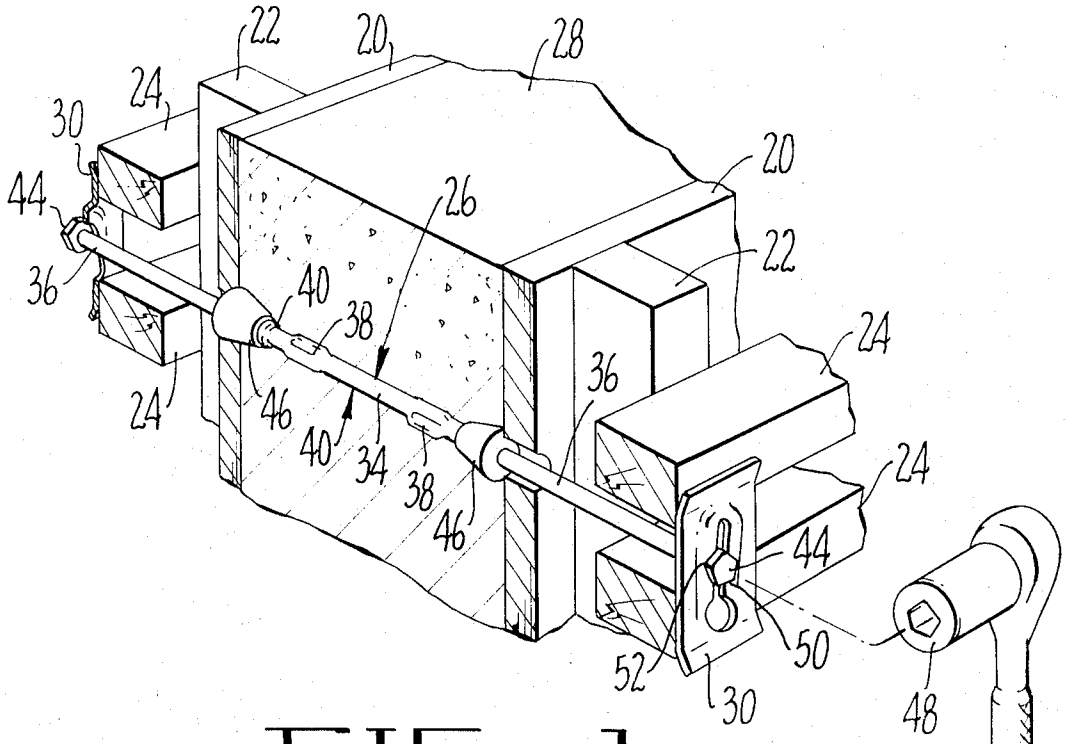



FIG. 1.

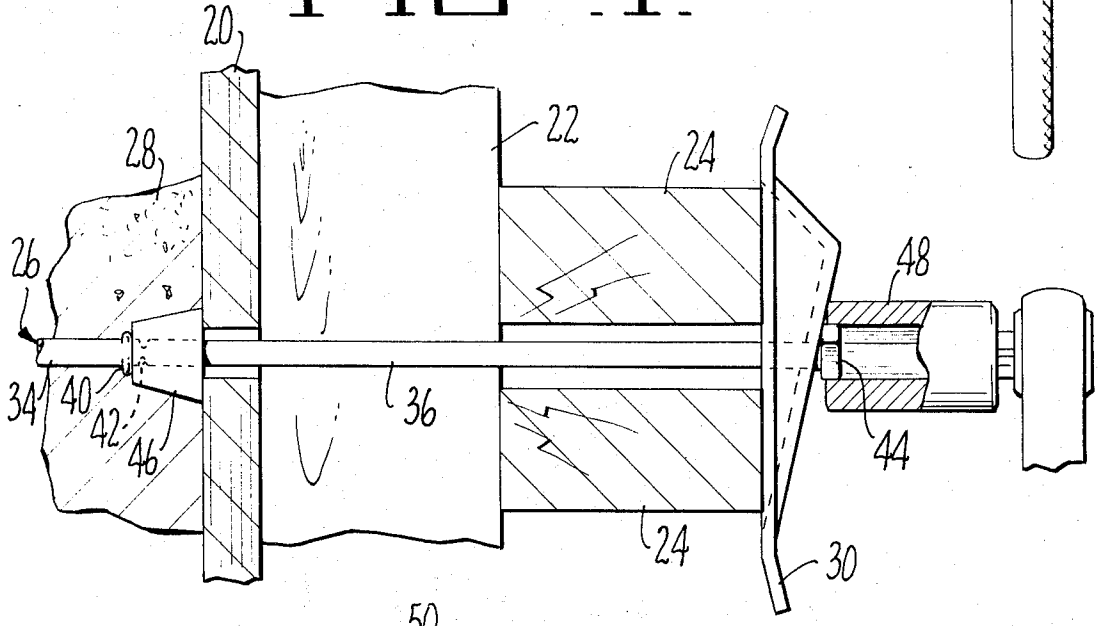



FIG. 2.

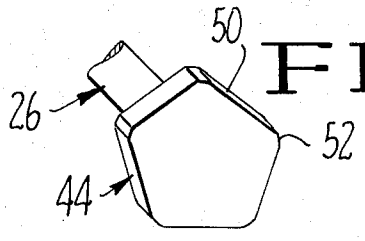



FIG. 3.

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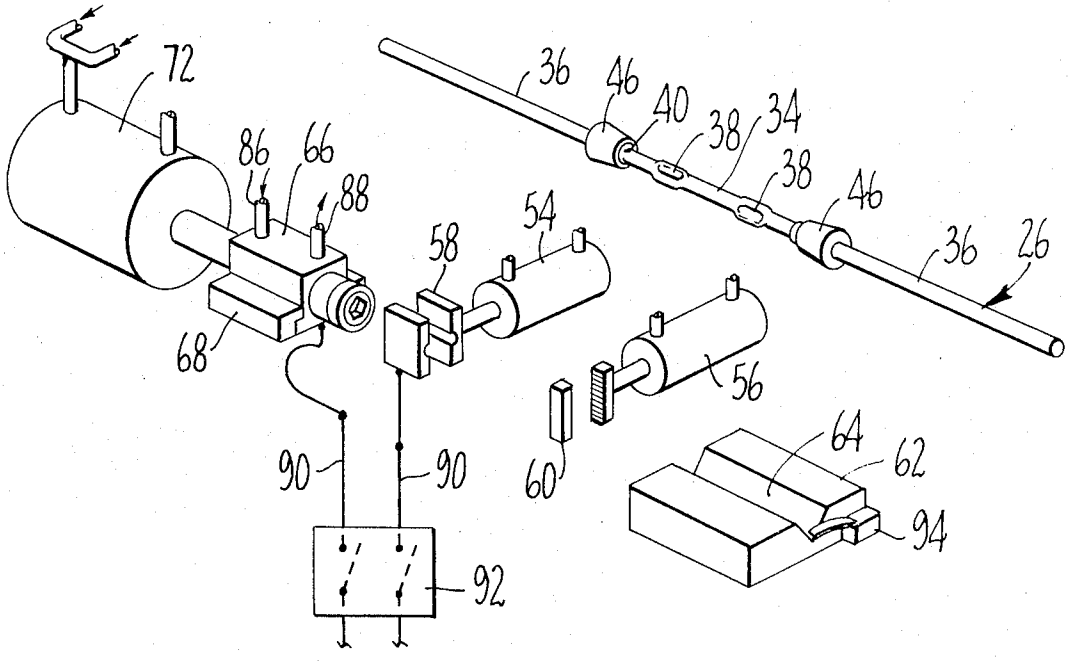



FIG. 4.

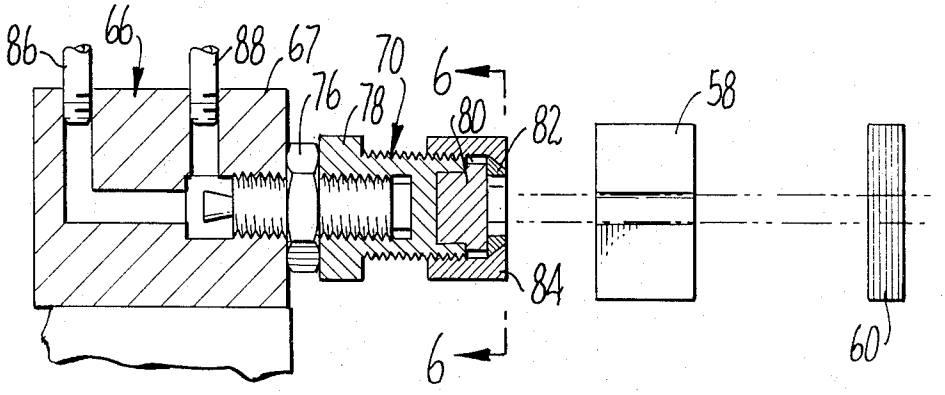



FIG. 5.

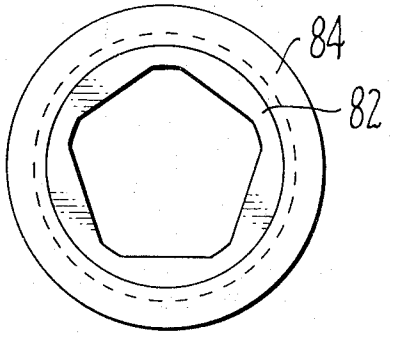



FIG. 6.

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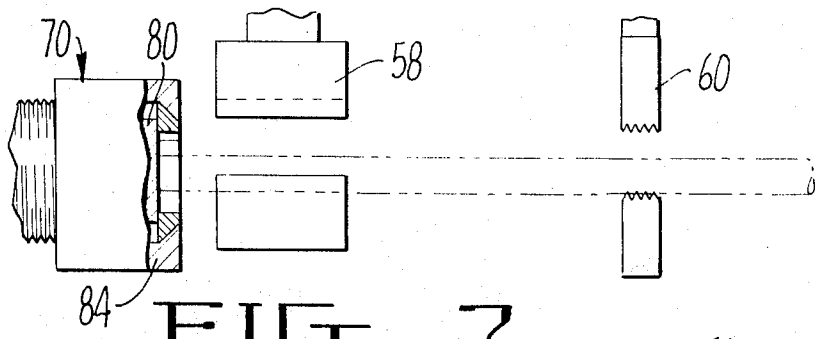



FIG. 7.

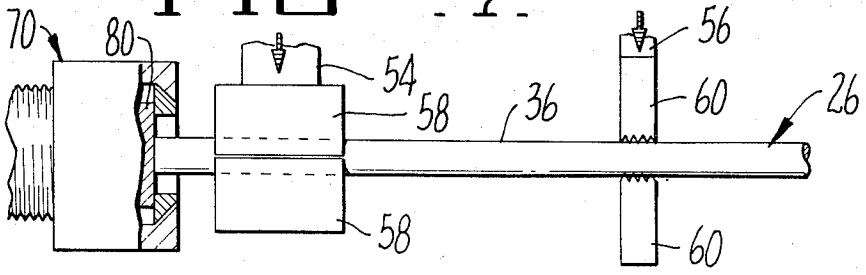



FIG. 8.

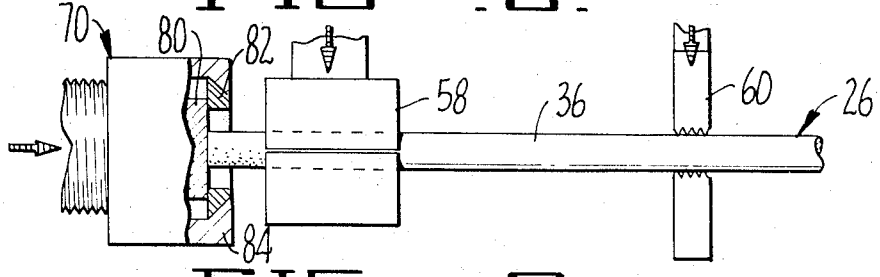



FIG. 9.

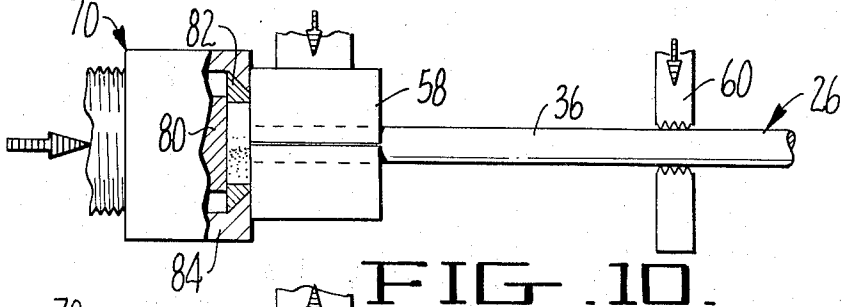



FIG. 10.

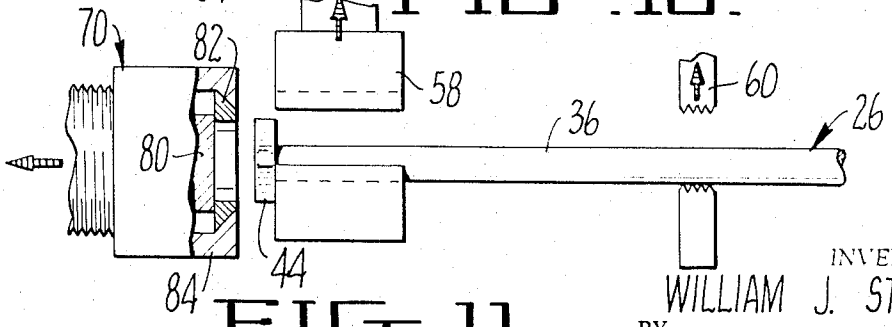



FIG. 11.

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# CONCRETE FORM SNAP-TIE ROD AND METHOD OF FORMING THE HEAD THEREFOR

## BACKGROUND OF THE INVENTION

The present invention relates to the art of concrete form tie rods known as "snap-ties" and to a method of manufacturing such ties through a technique wherein the heads thereon are formed by hot-upsetting. It is particularly concerned with a rod and method of manufacturing the same wherein the head of the rod has other than a round periphery so that it may be gripped by a socket wrench or the like.

Snap-ties have long been used to tie together concrete form panels to prevent the panels from separating under the weight of concrete poured therebetween. Typically, the ties extend through the panels at spaced centers and into engagement with waler brackets disposed externally of the panels. The ties are provided with enlarged heads which are gripped by the brackets to prevent the panels from separating and spacer means, such as collars on the tie rods, are provided to maintain the panels in spaced relationship relative to one another. Once concrete has been poured between the panels and has set, the ends of the tie rods are broken off and the panels are removed. To facilitate the breaking off operation the rods are provided with a frangible section positioned so as to be disposed internally of the concrete and this frangible section is designed to break upon the application of a predetermined torque to the end of the rod.

In the prior art, it is common to remove the form panels either prior to or after the breaking of the rods. Removal prior to breaking has the advantage that it facilitates ease of removal of the form panels. On the other hand, breaking of the rods after removal of the panels makes the rods easier to grip for twisting purposes. With the panel removed, for example, the end of the rod may be bent and used as a lever for twisting purposes. With he form panel in place, gripping of the end of the rod presents a problem, since the end is relatively small and generally has a round periphery. The problem is aggrevated by the fact that the tie rods and the ends thereof are generally fabricated of relatively high carbon steel which is very hard, and thus difficult to grip by using a wrench which relies on biting into the periphery.

Another difficulty in attempting to twist off the ends of the rods before the panels are removed is that the waler brackets must generally be removed. This is necessary, because when in place the brackets expose very little of the heads.

While the prior art has suggested the provision of concrete form tie rods with other than round heads, these have apparently failed to achieve any wide acceptance in the trade. Such heads may be seen in the following U. S. Pats.: Colt 2,335,236; Cooper 2,338,025; and Mushet 2,338,036. In addition to patents which show other than round heads, as exemplified by the foregoing patents, the prior art also contains patents wherein the end of the rod is formed with various types of irregular shapes, as may be seen for example from U. S. Pat. No. 2,245,559 to Kinninger. The absence of great acceptance of the other than round heads found in the prior art is believed to have resulted because these heads were not capable of being formed by the "hot-upsetting" technique which has become very popular for reasons economy and the strength and quality of the heads provided thereby.



In addition to the other than round heads suggested by the aforementioned art, the prior art has also suggested providing flats beneath round heads so that these flats might be gripped by a wrench. While this arrangement has achieved some acceptance in the trade, it has the disadvantage that it requires access to the area of the rods beneath the heads. As a result, it is generally necessary to remove the waler brackets before the rods can be gripped. Another disadvantage with this type of an arrangement is that it is not suitable for gripping through the employment of a socket wrench.

## SUMMARY OF THE INVENTION

In summary, the snap-tie rod of the present invention is concerned with a rod having an enlarged hot-upset head formed on at least one end thereof, said head having a generally flat underside merging into the shaft and a periphery with at least one distinct generally flat side. The preferred embodiment employs such a head wherein the periphery has a plurality of generally flat sides and adjacent sides define intersecting planes having an included angles therebetween of greater than 90° and less than 120°.

The method of the invention is concerned with a hot-upsetting technique for forming other than round heads on a rod wherein the rod is first heated to a temperature at which it may be hot forged, then confined peripherally within a die having at least one flat side, and then upset within the die to expand the end into engagement with the flat side of the die and substantially conform a portion of the periphery of said end to said side. In the preferred embodiment, axial flow of the end of the rod is restrained during upsetting to form a substantially flat underside on the upset end.

It is a principal object of the present invention to provide an other than round hot-upset end on a tie rod and a method of efficiently forming the same.

Another object of the invention is to provide a tie rod having a hot-upset end which may be gripped with a socket wrench.

Yet another object of the invention is to provide a tie rod having a hot-upset end which may be peripherally gripped with a wrench having generally flat gripping surfaces.

A further object of the invention is to provide a tie rod of the "snap-tie" type which may be broken without the necessity of first disengaging and/or removing a waler bracket engaged therewith.

Still another object of the invention is to provide a tie rod having a hot-upset end with distinct flat peripheral surfaces and rounded apexes between the surfaces.

Still another object of the invention is to provide a tie rod having a head of regular pentagonal shape which facilitates it for effective wedging inter-action with a mating socket wrench.

A further object of the invention is to provide a tie rod having a head with an other than round periphery which is well suited for use with hardware designed for use with conventional rods having heads with round peripheries.

With respect to the method of invention, it is a principal object to provide a method wherein distinct flat sides may be formed on the head of a tie rod by a hot-upsetting process.

Another object of the method is to provide a method wherein such distinct flat sides may be rapidly and economically formed.

## BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects and the particulars of the invention will become more apparent when viewed in light of the following detailed description and the accompanying drawings, wherein:

FIG. 1 is a perspective view, partially in section, illustrating a pair of form panels coupled by tie rods constructed according to the present invention;

FIG. 2 is a sectional elevational view, with parts thereof broken away, illustrating the tie rod of the present invention extending through a form panel, with a socket wrench applied to the head of the rod;

FIG. 3 is a perspective view, with parts thereof broken away, illustrating the head of a tie rod constructed according to the present invention;

FIG. 4 is a perspective view diagrammatically illustrating the apparatus used for the hot-upsetting method of the present invention;

FIG. 5 is a sectional elevational view, with parts thereof broken away, illustrating the upsetting abutment and die employed in the method of the present invention;

FIG. 6 is a cross-sectional view taken on the plane designated by line 6—6 of FIG. 5;

FIGS. 7, 8, 9, 10 and 11 are plan views, partially in section, sequentially illustrating the steps of hot-upsetting the end of a rod through the method of the present invention.

## DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Referring now to FIG. 1, therein is illustrated a pair of form panels 20 having vertically walers 22 and horizontal walers 24. The panels are secured in spaced relationship by a snap-tie rod 26 and are shown as having concrete 28 poured therebetween. While only one snap-tie rod is illustrated, it is to be understood that a plurality of such rods would be used, with the respective rods being at spaced centers. Waler wedges 30 are shown engaged with the ends of the rod externally of the walers 24.

The snap-tie rod 26 is formed of carbon steel, such as SAE 1040 and comprises an elongated body portion having a central section 34 and identical end sections 36. The central section 34 is formed with a pair of flats 38, a pair of buldged portions 40 and a pair of crimped frangible portions 42. The frangible portions 42 are fragible responsive to the application of a predetermined torque thereto to permit the end sections to be broken away from the central section. The end sections 36 extend outwardly from the frangible portions and terminate in enlarged heads 44. The rod carries a pair of cones 46 diposed in abutting engagement and to the outside of the buldges 40.

In the assembled condition shown in FIG. 1, the divergent ends of the cones 46 assume abutting engagement with the inside surfaces of the form panels 20 and the heads 44 are engaged by the waler wedges 30. Thus, the cones function to maintain the panels in spaced relationship and the heads prevent the panels from separating. In the assembled condition, the flats 38 assume a disposition within the concrete 20 and, thus, function to lock the rod against twisting relative to the concrete once the concrete has set.

With the exception of the heads 44, the aforedescribed structure of the tie rod 26 and the manner in which this structure cooperates with the form panels, walers and waler wedges is relatively conventional. As in conventional arrangements, once the concrete has set, torque may be applied to the ends of the tie rod to twist the rod off at the crimped frangible portions 42. Once so twisted off, the end sections of the rods, together with the cones 46 may be removed.

The heads 44 are unique and result in a unique snap-tie rod because they are hot-upset and have other than round peripheries. This is contrasted to conventional tie rods employing hot-upset heads wherein the peripheries of the heads are round. In the preferred embodiment illustrated, the other than round peripheries of the heads are of regular pentagonal shape.

From an operational standpoint, the other than round heads 44 have the advantage that they may be engaged and twisted by a socket wrench without the necessity of first disengaging the waler wedges 30. Such a wrench is illustrated in FIGS. 1 and 2 and designated by the numeral 48. This advantage is very desirable in that it permits the end sections of the rods to be broken away as the first step of removing the form panels, walers and waler wedges. This is to be contrasted with the conventional arrangements wherein the heads are round and it is necessary to at least remove the waler wedges before the heads can be gripped and twisted.

The detailed construction of the head 44 can best be seen from FIGS. 2 and 3. From these figures it can be seen that the underside of the head merges directly into the end section 36 of the tie rod. Thus, as in conventional hot-upset heads, the underside of the head is directly engageable by the waler wedge. The periphery of the head is of regular pentagonal shape and is defined by plurality of flat sides 50 having rounded apexes 52 therebetween. In the prefed form wherein the periphery of the head is of regular pentagonal shape, the angle included between the intersecting planes defined by adjacent sides of the head is 108°.

FIG. 4 shows an unheaded tie rod and diagrammatically illustrates the apparatus used for forming the pentagonal heads 44. The apparatus comprises a series of aligned elements adapted to fixedly clamp a tie rod in place, then heat, and then hot-upset the end of the rod into the form of a head. The apparatus is conventional, with the exception of the fixtures used to form the head into the other than round shape. The basic apparatus comprises: first and second pneumatically operated grippers 54 and 56 having aligned jaws 58 and 60, respectively; an alignment fixture 62 having a V-groove 64 therein in alignment with the jaws 58 and 60; an upsetting slide 66 mounted in guides 68 for back and forth movement relative to the jaws 58 and 60 in a path aligned therewith; a resistance heater 70 carried by the slide 66 in alignment with the jaws 58 and 60; and, a double acting pneumatic cylinder 72 connected to the slide 66 to impart back and forth movement thereto.

The detailed construction of the resistance heater may best be seen from FIG. 5. As there shown, the heater comprises: an adapter 76 threadably received within a passage in the slide 66; an adjusting union or converter 78 threaded onto the adapter 76; a heading tip 80 received within the converter 78; a contour die 82 juxtaposed to the tip 80 in alignment with the jaws

58 and 60; and, a die holder 84 threadably secured to the converter 78. The contour die is held in place against the heading tip by mating generally frustoconical surfaces formed on the exterior of the die and the interior of the holder. Interiorly, the die is of regular pentagonal shape with rounded apexes, as may be seen from FIG. 6.

Water conduits 86 and 88 extend into the slide 66 and communicate with passages in the adapter 76 to provide for cooling of the heater 70. Electrical leads are connected to the heater 70 and the jaws 58 so that a circuit may be completed therethrough and through a rod engaged therebetween. It is through the completion of this circuit that the end of the rod is resistance heated prior to upsetting. The leads are designated by the numeral 90 and are shown as having a relay 92 interposed therein. A switch 94 is mounted on the fixture 62 for triggering by a rod received therein. Triggering of the switch, as will also become apparent from the subsequent discussion, starts the sequential heading operation.

It is here noted that the contour die 82 and die holder 84 are preferably fabricated of molybdenum. Fabrication of the die and holder as separate elements has the advantage that the die may be replaced without replacement of the holder.

Prior to the formation of the heads through the apparatus shown in FIG. 4, the rod is fabricated into the form shown in FIG. 4 through conventional techniques. During this preliminary fabrication, the flats 38, buldged portions 40 and crimped frangible portions 42 are formed and the cones 46 are slipped into place. Thus, the rod is complete, with the exception that the heads are not formed thereon.

The method of the present invention may best be appreciated from the sequential operation illustrated in FIGS. 7 to 11. In FIG. 7, the upsetting machine is shown conditioned for the receipt of a rod. This is the same condition shown in FIG. 4. As so conditioned, the jaws 58 and 60 are separated sufficiently to permit a rod to be easily inserted therebetween. With the jaws so conditioned, the operation is commenced by inserting the rod into the phantom line position shown in FIG 7. As so inserted, the end of the rod is positioned so as to abut the heading tip 80 and the body of the rod is positioned so as to rest in the V-groove 64 of the alignment fixture 62.

Positioning of the rod as shown in FIG. 7 functions to close the switch 94 which, in turn, starts the automatic sequence of the machine. While the switch 94 is provided so that placement of the rod automatically starts the automatic sequence, it should be understood that the switch 94 might be omitted and that a separate manually operated switch might be provided to start the sequence. In either event, however, the operation would be the same, once the sequence was triggered.

The first step of the automatic sequence is shown in FIG. 8 wherein the jaws 58 and 60 are shown as moving into gripping engagement with the rod. In actual operation, the jaws 60 close slightly before the jaws 58. It is noted that the jaws 60 are steel and provided with serrated surfaces to securely lock the rod against axial movement. The jaws 58 are copper and are provided both to secure the rod and establish electrical connection thereto through one of the leads 90, as may be seen from FIG. 4. The interior surfaces of the jaws 58 are grooved to complement the exterior surface of the rod.

After the rod is securely gripped as shown in FIG. 8, the pneumatic cylinder 72 is automatically activated to apply light pressure to the upsetting slide 66, and, thus, force the tip 80 into secure electrical contact with the end of the rod. Simultaneously with this step, or immediately thereafter, the resistance heater 70 is activated by closing of the relay 92. This, in turn, functions to resistance heat the end of the rod. FIG. 9 is intended to depict the rod in the course of being resistance heated with the heating tip forced gently thereagainst through operation of the cylinder 72.

Once the end of the rod is heated to a temperature at which it may be hot forged, the next step is to apply upsetting force as shown in FIG. 10. This force is applied through the cylinder 72 and functions to move the heating tip to the right (as viewed in FIG. 10) and upset the end of the rod into the form of a head. The upsetting stroke is so chosen that the periphery of the head is expanded to contact and conform with the flat surfaces of the interior of the contour die. Thus, the periphery is formed with flats conforming to the flats of the die. Simultaneously with the formation of the periphery of the head, the underside of the head is formed with a flat surface by abutment with flat surfaces formed on the left side of the jaws 58 (as viewed in FIG. 10). Thus, with the formation stoke complete as shown in FIG. 10, the head is confined between the heading tip 80, the jaws 58, and the interior periphery of the contour die 80.

Once the head is completely formed, as shown in FIG. 10, the sequential operation is completed as depicted in FIG. 11 by retracting the upsetting slide 66 and then disengaging the jaws 58 and 60. Thus, the die is pulled from the head and the rod is disengaged from the jaws and may be removed. The resulting head formed on the rod then conforms to that shown in FIG. 3.

The operation described with respect to FIGS. 7 through 11 concerns the formation of a head on only one end of the rod. The other end of the rod would be similarly headed by turning the rod end-for-end and repeating the operation. Alternatively, the mechanism shown in FIG. 4 might be essentially duplicated so that both ends of the rod could be simultaneously formed.

The formation of other than round heads through the foregoing method has the advantage that may be efficiently and economically employed with rod fabricated of conventional carbon steel. Depending upon the strength characteristics required, it has been found that steel from SAE 1036 to 1090 might very easily be used. While lower carbon steels could be used, they would generally be undesirable because they would not have the strength and snapping characteristics typically required for "snap-tie" rods.

The parameters of the method of the present invention will vary, depending upon the rod dimensions and the type of steel used for the rods. With "Concrete Form Twist or Snap Tie Wire," designated "3M," and a rod diameter of 0.2253±0.002 inches, to achieve a head having a thickness of 0.125 inches, an outside circle diameter of 0.549 inches and an inside circle diameter of 0.510 inches, the following conditions have proved ideal:

1. Heating Time — 2 seconds
2. Ultimate Temperature — 2200° F.
3. Upsetting Pressure — 80 P. S. I.
4. Upsetting Stroke — 0.570 inches

5. Time for Upsetting Stroke — 2 seconds

This particular wire designated 3M, has a carbon content in the range of SAE 1036 to 1042. Concrete Form Twist or Snap Tie Wire is available in designations known as 3M, 5M, and 7M, with the higher numbers indicating a higher carbon content. The carbon range covered by these designations is from a low of SAE 1036 to a high of SAE 1090.

While these parameters may vary for different steels and rod head sizes, the basic method remains the same. Commercially available hot upsetting machines may be easily adjusted to provide the operating conditions required. Ideally, however, the end of the rod should first be heated to a temperature at which it may be hot forged and upset in a single stroke into the ultimate head shape desired.

The regular pentagonal peripheral shape of the head on the rod of the present invention was chosen both for ease of manufacture and its ideal operational characteristics. As compared to a head having four or less sides, it has the advantage that it may be more easily hot upset to final dimensions in a single stroke and also that it may be readily employed with presently available hardware designed for use with tie rods having heads with round peripheries. As compared with heads having six or more sides, it has the advantage that the sides may be formed into distinct flat configuration with a single hot upsetting stroke, which configuration is uniform and capable of ready gripping by a socket wrench. From experimentation, it was found that efforts to hot upset into a hexagonal periphery in a single stroke resulted in peripheral configuration so nearly round that it could not be reliably gripped with a socket wrench. Experimentation also indicated that the sharp angles on heads having peripheries of square or triangular configuration were difficult to reliably form in a single stroke by hot upsetting process and that such heads were not well adapted for use with conventional hardware designed for use with heads of round peripheral configuration. Accordingly, in keeping with the present invention it has been found ideal to form the head so that the intersecting planes defined by adjacent sides of the periphery of the head have an included angle therebetween of greater than 90° and less than 120°. The included angle for the regular pentagon of the preferred embodiment is 108°.

The rounded apexes of the periphery of the heads formed according to the present invention also have the advantage that they minimize socket wrench wear. This is particularly advantageous where the head is fabricated of high carbon steel, since sharp apexes would function to rapidly wear away a socket used therewith.

From the foregoing detailed description, it should be apparent that the present invention provides for the attainment of the objects initially set forth herein. It should be understood, however, that the invention is not intended to be limited to the specific embodiments illustrated and described, but rather defined by the following claims.

I claim:

**1.** A method of forming a head of polygonal peripheral shape on an end of a carbon steel snap-tie, said method comprising:

a. moving the end of the rod into a contour forming die having an internal peripheral shape conforming substantially to the external peripheral shape of the head to be formed on the rod and against a heading tip juxtaposed to one side of the die, said die having an interior surface defined by a plurality of flat sides with adjacent sides defining intersecting planes having an included angle therebetween of greater than 90° and less than 120° and said sides including therebetween a diameter greater than the diameter of the end of the rod;

b. heating the end of the rod to forging temperature within the die by establishing an electrical resistance heating circuit through the end of the rod and the heading tip; and,

c. upsetting the end of the rod against the heading tip by a single stroke sufficient to expand the rod into contact with the die to form a head on the rod with flat peripheral surfaces substantially conforming to the flat sides defining the interior surface of the die and with rounded peripheral apex surfaces between said flat surfaces, the volume of the end so upset being such as to not flare out around the die.

**2.** A method according to claim **1** further comprising confining the end of the rod between the heading tip and a secondary abutment surface during upsetting to restrict axial flow of the end during upsetting and form a substantially flat underside on the upset end.

**3.** A method according to claim **1** wherein the interior surface of the die is of regular pentagonal shape.

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