Nov. 22, 1927. **1,649,929**

F. J. SENIOR

METHOD OF AND APPARATUS FOR PRODUCING CAP SCREWS AND THE LIKE

Filed Nov. 16, 1923 3 Sheets-Sheet 1

Fig. 1.

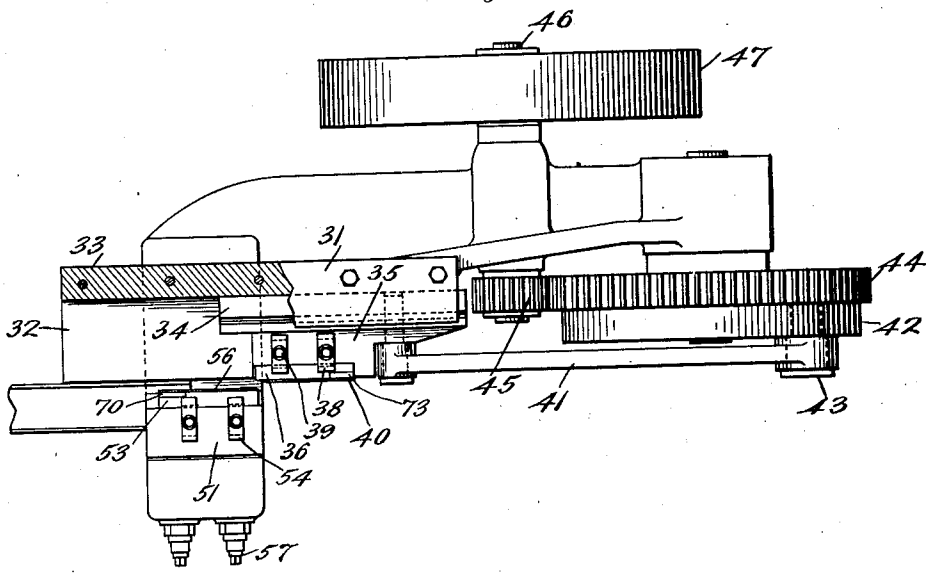
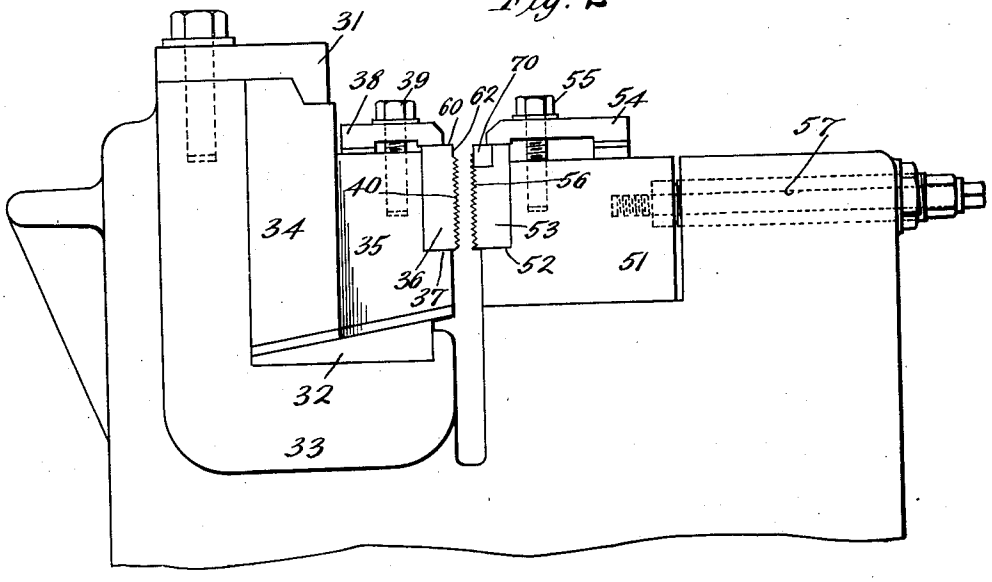


Fig. 2



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Fig. 3.

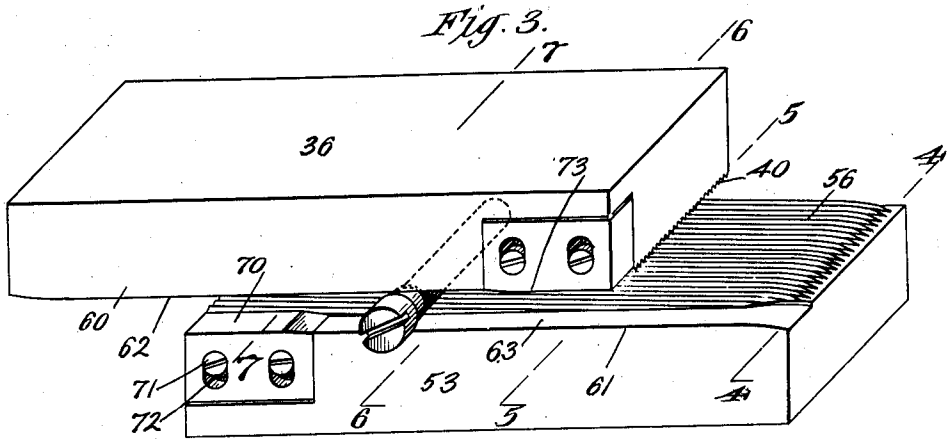


Fig. 4.

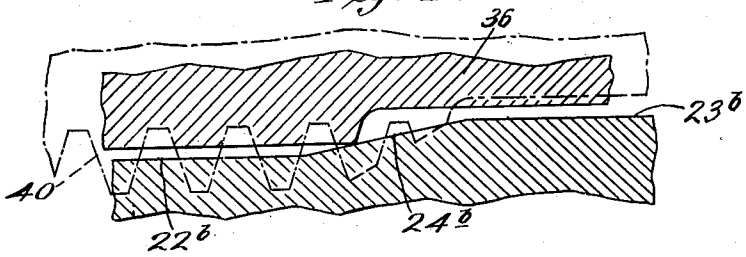


Fig. 5.

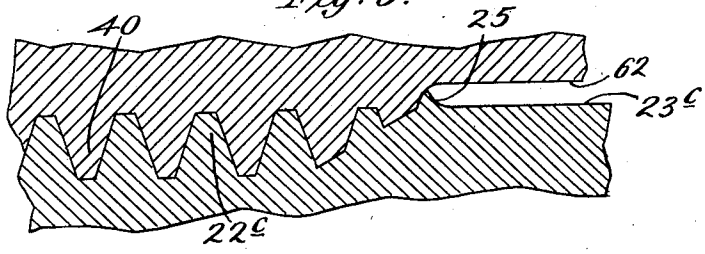
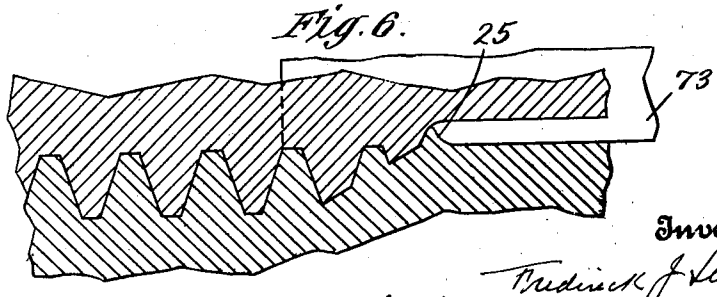


Fig. 6.



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METHOD OF AND APPARATUS FOR PRODUCING CAP SCREWS AND THE LIKE

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Fig. 7.

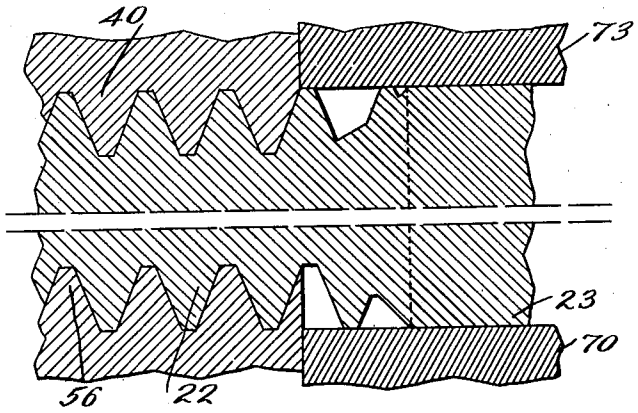


Fig. 8.

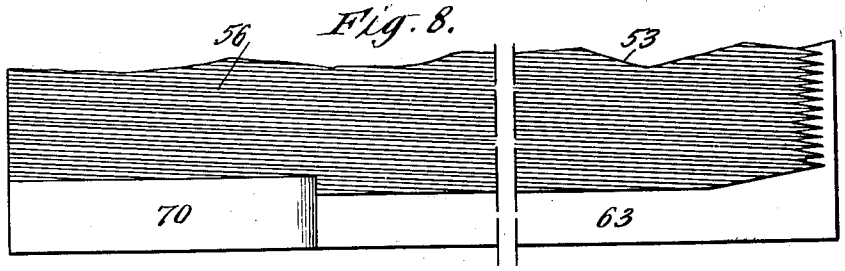


Fig. 10.

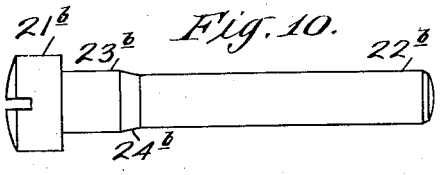


Fig. 11.

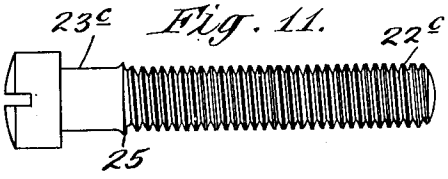


Fig. 9.

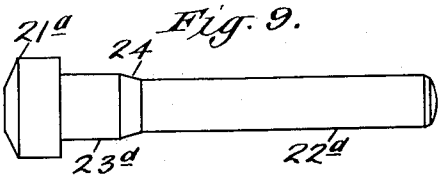


Fig. 12.



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Patented Nov. 22, 1927. 1,649,929

UNITED STATES PATENT OFFICE.

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METHOD OF AND APPARATUS FOR PRODUCING CAP SCREWS AND THE LIKE.

Application filed November 16, 1923. Serial No. 675,057.

This invention relates to a method of and apparatus for producing cap screws and the like, and to blanks therefor.

Cap screws, as known in the trade, usually comprise a polygonal, fillister, flat or round head, a threaded shank, and an unthreaded portion between shank and head which may be termed a shoulder. Ordinarily, the diameter of the shoulder corresponds to the outside or crest diameter of the threaded shank.

Attempts have been made, from time to time, to produce cap screws by die-rolling the threads—a method of threading considered preferable to cutting because of its economy. In threading by die-rolling there must be some flow of metal—either radially or longitudinally of the blank. In the former case the metal flows outwardly to form the thread crests. Consequently the blanks are stepped; that is, the shank before threading has a smaller diameter than the shoulder. It is to this general mode of rolling threads that the present invention relates. The results of the attempts referred to, however, have not been altogether successful. For example, the screws produced have been objectionable to users because they do not resemble in appearance and do not have the strength of a cap screw formed by cutting the thread. Another objection is found in the matter of forming the shoulder. It is desirable to have the shoulder properly finished and accurate in size. The shoulders of the blanks, as above stated, are larger in diameter than the shanks because the metal of the shanks, during rolling, is displaced outwardly to form the crests of the threads. In carrying out the attempted methods referred to, when the blank is passed between the threading dies the shoulder also is rolled for finishing. It is difficult, however, to control the dimensions of the enlarged shoulder in forging the blank. Consequently, if the shoulder of the blank is undersize the shoulder after rolling remains undersize and lacks finish; if oversize, the tendency during rolling is to elongate the blank or break the dies.

It is one of the principal objects of the present invention to provide an improved method of and apparatus for producing cap screws and the like, such that die-rolling may be utilized for threading the blanks; such that the product approximates, in appearance and strength, a cut thread product; and such that the shoulders of the screws produced are true to size and have a proper finish.

With this general object in view, the invention consists in the method, articles, combinations, details of construction, and arrangements of parts which will first be described in connection with the accompanying drawings and then more particularly pointed out.

In the drawings—

Figure 1 is a plan view, with parts in section, of an apparatus constructed in accordance with the invention;

Figure 2 is an end view of the same;

Figure 3 is a perspective view (enlarged) of the two dies shown in Figs. 1 and 2;

Figure 4 is an explanatory sectional view taken at right angles to the die threads and through the blank and upper die of Fig. 3, when the blank is at the line 4—4 of Fig. 3, and the upper die is at a corresponding position;

Figures 5 and 6 are similar views taken when the blank is at the lines 5—5, 6—6, respectively, in Fig. 3, and the upper die is moved accordingly;

Figure 7 is a similar view but showing both dies, when the blank is at the line 7—7 of Fig. 3 and the upper die is moved accordingly;

Figure 8 is a top plan view of part of one of the dies;

Figure 9 is a side view of a rough blank;

Figure 10 is a similar view of an intermediate blank;

Figure 11 is a similar view of the blank threaded but unfinished; and,

Figure 12 is a similar view of the finished product.

Referring to the drawings, the desired product is a cap screw such as that shown as an example, in Fig. 12. It has a head 21, a threaded shank 22, and an unthreaded shoulder 23. The shoulder diameter is approximately the outside or crest diameter of the threaded shank. The shoulder has true diameter and is properly finished, and the thread terminates regularly and definitely at the shoulder. In short, the screw as a whole approximates, in appearance and strength, a cap screw the threads of which have been formed by cutting.

According to the present invention, briefly stated, a blank is so formed and the blank is so threaded that the final turn of the thread adjacent to the shank has full crest diameter. Beyond the final turn of the thread the metal of the blank is upset in the form of a ridge or burr which, after threading, is removed. And at some stage in the procedure the shoulder is machined to size. In carrying out the invention according to what is now considered the best plan of operation, the shoulder is machined before die-rolling, and the burr is worked into a prolongation of the shoulder to carry the shoulder down to a thread turn of full outside diameter.

In carrying out the invention along the lines stated, the finished product referred to may be formed from a rough blank such as is shown, for example, in Fig. 9. This blank has an unfinished round head 21^a, a shank 22^a, and a rough finished shoulder 23^a which is somewhat oversize as to diameter and undersize as to length. Between the shank and shoulder is a bevel 24, hereinafter more fully referred to. This blank may be formed in any suitable manner, as by forging from round stock in a heading machine. The head 21^a is finished, as by milling or die-cutting, to form the desired head. Fig. 12 shows a fillister head but the head may be polygonal, flat or round, the head finishing being a well known operation and forming no part of the present invention. The shoulder 23^a is machined, i. e. cut, to true final diameter, thus giving it the desired finish and accurate size. This machining of the shoulder may conveniently be done when the head is machined to trim the top and bottom thereof.

The above described operations provide what may be termed an intermediate blank, such as illustrated in Fig. 10. This intermediate blank has a finished head 21^b, a shank 22^b and a shoulder 23^b which is finished to the final shoulder diameter but is somewhat undersize as to length. The total length of the intermediate blank is approximately the length of the screw when finished. The difference in diameter between shoulder and shank equals the amount by which the metal of the shank will be thrown outwardly in rolling the thread. Between shoulder and shank is a bevel 24^b. The angle of the bevel and the deficiency in shoulder length are hereinafter referred to.

The intermediate blank is die-rolled to thread the same, the threading extending along the shank and part way up the bevel, the extent being hereinafter more fully referred to. This die-rolling operation is such as to upset the rolled metal into the form of a thread. The metal of the blank is caused to flow outwardly to form the thread crest, the outside diameter of which is approximately that of the finished shoulder. During the rolling operation described, only that part of the blank that is to be threaded is die-rolled, the shoulder and upper part of the bevel being left free. During threading, some of the metal of the bevel of the blank is caused to be upset and displaced outwardly into the form of a ridge or burr beyond the final turn of the thread.

Fig. 11 illustrates this stage of the production. The uncompleted screw there shown has a threaded shank 22^c and an unthreaded shoulder 23^c. Beyond the final turn of the thread, adjacent the lower end of the shoulder is a ridge or burr 25 slightly greater in diameter than the shoulder. The shoulder, for the most part, remains unchanged but there may be a slight enlargement of the lower end of the shoulder due to the crowding of the metal in forming the burr. Should this occur it is corrected when the burr is removed, as later described.

While the operations described may be carried out by apparatus of various constructions, the invention in its entirety includes a suitable apparatus, one embodiment of which is illustrated in the drawings. Apparatus constructed in accordance with the invention includes two complementary threading dies between which the blank rolls as the thread is formed. As here shown as an example, slidable in upper and lower tracks 31, 32 of a bed block 33 is a slide 34 having a die carrying portion 35. This latter carries a flat, substantially rectangular die block 36 which rests on a ledge 37 of the carrier 35 and is secured in place by means of clamps 38 and bolts 39. The outer vertical face of the die block has a series of threading teeth 40 hereinafter referred to. To reciprocate the die block 36, as here shown as an example, secured to the slide 34 is the end of a pitman 41 driven from a rotary disk 42 by a crank pin 43 mounted therein. Disk 42 is connected with a gear 44 meshing with a pinion 45 on a drive shaft 46. This shaft is rotated by a pulley 47 to which power may be applied in any suitable manner. As the drive shaft rotates the slide 34 is moved forward and back in the bed block, thereby causing endwise reciprocation of the die 36.

Opposite the reciprocating die 36 is a complementary die which, in the present embodiment, is stationary. To this end, as shown, carried by the frame or bed block is an adjustably mounted supporting block 51. The block 51 has a ledge 52 on which is supported a die block 53 held in place by clamps 54 and bolts 55 and arranged on a level with die block 36 (Fig. 2). The outer vertical face of the die block 53 is formed with a series of parallel rectilinear teeth 56 running endwise of the block but at an angle to the longitudinal axis thereof (Fig. 8). The

teeth 40 of die 36 are similarly arranged, the teeth of one die, however, being opposed to the intervening grooves of the other die. As will be understood by those skilled in the art, the angle of the die teeth with respect to the longitudinal axis of the die block, that is, with respect to the direction of travel of the blank, governs the lead of the thread formed. In carrying out the invention as here illustrated as an example, the die blocks 36, 53 are located substantially parallel and so spaced apart that the tooth crests are separated by a distance less than, and the groove bottoms by a distance greater than the diameter of the shank of the blank. That is, the groove bottoms, which determine the thread crest, are spaced apart a distance approximately equal to the diameter of the desired product. In the embodiment illustrated the position of die block 36 may be adjusted by the use of shims. Die block 53 is adjusted by adjustment of the supporting block 51 by means of bolts 57.

To facilitate the entrance of the blank between the dies, the opposing ends of the dies are sloped or rounded off as appears in Figs. 1 and 3, giving, in effect, a bell-mouth entrance for the blank.

In the apparatus here shown as an example, the ends of the teeth of the dies along the sides of the dies toward the blank head—or what may be termed the trailing ends of the die teeth—are ground or chamfered off at an angle to the plane of the tops of the teeth (Figs. 4–6). The angle of chamfer is later referred to. While one purpose of so constructing the dies is to prevent the die teeth from chipping and breaking off at the trailing ends during the threading operations, such a die construction cooperates conveniently with the bevel of the blank in the production of the desired product.

In carrying out the invention in its entirety, the main portion of the thread is started prior to the final turns thereof. This may be accomplished by die-rolling the blank between dies so formed that the teeth which roll the main portion of the thread have an initial position in advance of the teeth which roll the final turns of the thread. The drawings illustrate dies adapted to accomplish this step. As illustrated in Fig. 8, the greater part of the die teeth of die 53 start at the forward end of the block. At the side of the die that is toward the blank head, however, the final few teeth start progressively to the rear, as shown in the lower right hand corner of Fig. 8. It will be understood that the die 36 is similarly formed. With the dies described the main part of the thread is well started before blank reaches the teeth that form the final turns of the thread.

With the movable die drawn back to the end of its idle stroke (Fig. 1), a blank is positioned adjacent the opposing ends of the complementary dies. To this end, there is provided means for fixing the position of the blank with respect to the die teeth. That is, in terms of the embodiment illustrated, there is provided means for fixing the vertical position of the blank. As here shown as an example, the die block 36 extends beyond the line of termination of the chamfered die teeth so that its top edge forms a ledge 60 for receiving the head of a blank. The die block 53 is similarly formed to provide a ledge 61. These ledges receive the underside of the head of the blank which is thus suspended between them. The ledges 60, 61 are spaced from the line of termination of their respective die teeth a distance to cause the blank to be so positioned with respect to the die teeth that the desired point on the blank comes opposite the line of termination of the teeth. In other words, the blank should be so positioned that the shoulder and part of the bevel are beyond (above) the die teeth. As is known to those skilled in the art, there is a tendency for the blank to jump endwise in the direction of its head when the teeth take hold. Consequently, unless hold-down devices are used, this jump must be allowed for in positioning the blank. The approximate amount of this jump, for a given set of dies, being known or readily ascertained, the ledges are spaced from the die teeth accordingly. The ledges initially position the blank, which then jumps, and thereafter the blank is held in the same relative axial position by the inter-engagement of the die teeth and the forming thread.

Due to the extension of the die blocks 36, 53 to form the ledges 60, 61, the die blocks have plain surfaces 62, 63, that come opposite the shoulder and part of the bevel of the blank. When the die blocks are in place, as here shown, the plain surfaces 62, 63 are spaced apart a distance substantially greater than the diameter of the shoulder 23^b of the blank. Or, in terms of one die, its plain surface 62 (or 63) is located in a plane not only below the teeth but below the plane of the bottom of the teeth (Fig. 2). Consequently, when a blank is being threaded, the surfaces 62, 63 leave the shoulder of the blank entirely free and do not contact with the blank or any part thereof. In other words, the surfaces 62, 63 play no part in the threading operation except in that the ledges 60, 61 position the blanks in feeding.

A blank being suspended in position, as above described, the moving die 36 is advanced and the blank is rolled between the two dies. That is, the blank revolves on its own axis and travels along between the dies as the moving die advances. For a half turn of the blank the teeth of die 36 form thread portions in half the surface of the

blank and the teeth of die 53 form thread portions in the other half of the blank surface, the die teeth digging into the metal to form the thread grooves and displacing the metal outwardly into the die grooves to form the thread crest. During the next half turn of the blank the half thread portions formed by die 36 are presented to die 53 and the half thread portions formed by die 53 are presented to die 36 for further formation or finishing or both. With the apparatus described, the complete thread is roughly formed during the first half turn or few half turns of the blank, the remainder of the action being in the nature of a finishing or planishing operation. During this threading operation, the chamfered portions of the die teeth, acting on the bevel of the blank, thread part of the same and upset some of the metal into the form of a ridge or burr beyond the final turn of the thread. Fig. 4 shows the start of the operation and illustrates the relation of blank and dies. It is to be understood that the moving die is drawn back from the position of Fig. 3 and has just started to the left as viewed in Figs. 1 and 3. The oncoming die teeth, because of the die block formation, are indicated in dotted lines. This figure also shows the relation between the bevel of the blank and the chamfered die teeth. Fig. 5 illustrates the parts after the moving die has progressed far enough to form the thread. The die teeth have dug into the blank to form the thread groove and the metal has been displaced into the die grooves to form the thread crest. Fig. 5 also illustrates how the chamfered ends of the die teeth have threaded part of the bevel and have upset the metal into a burr 25 beyond the final turn of the thread.

In the completion of the desired product, the burr above referred to is removed and the shoulder lengthened to final size. This may be accomplished by working the upset metal into the shoulder to elongate it, the shoulder being carried down to a thread turn of full outside diameter. For example, the partly finished blank may be subjected to a rolling action which rolls the burr down to shoulder diameter, the metal thus displaced being received by the final turn of the thread.

This may be accomplished, for example, by apparatus including platens or planishing dies, spaced apart a distance substantially equal to the shoulder diameter, and between which the blank is rolled. One embodiment of such an apparatus is shown in the drawings, the planishing dies being incorporated as part of the die block units described. As here shown, the corner of the die 53 at the rear end and at the side toward the head of the blank (the lower left corner in Fig. 8) is cut away to receive a platen or planishing die block 70. This platen is a substantially rectangular block having its longer axis in the direction of the blank travel. Its outer side and end coincide with the corresponding side and end of the die block 53 (Fig. 3). Its blank-engaging surface is substantially parallel to the plane of the tops of the die teeth except that the forward end is slightly rounded off to facilitate reception of the blank. The platen has a length such that it can act on the blank during several turns of the latter but such that it is not reached by the blank until the threading operation is finished. The width of the platen is equal to the plain surface 63 plus several die teeth, or, in terms of the blank, it is wide enough to come opposite the shoulder of the blank and several turns of the thread. The platen is so associated with the die block 53 that its blank engaging surface lies approximately in the plane of the bottom of the die teeth.

In the embodiment illustrated, the platen 70 is adjustably secured in the cutout recess in the die block 53 by screws 71 passing through slots 72, and may be adjusted by the use of shims. Cooperating with this platen 70 is a complementary platen 73 like platen 70 and similarly set in the corresponding corner of die block 36. As the die 36 moves across the die 53, and near the end of the stroke, the platen 73 comes opposite platen 70 and part of the blank is rolled between them. As each platen has its planishing surface in the plane of the bottom of its respective die teeth, the two platens are separated a distance substantially equal to the diameter of the shoulder of the blank. During the rolling operation the upset metal of burr 25 is rolled down by the platens or planishing dies 70, 73, the displaced metal being received by the final turn of the thread. That is, the metal is worked into the shoulder to elongate it, carrying the shoulder down to a thread turn of full outside diameter. It will now be apparent that if the shoulder 23c of the partly completed blank was increased in diameter in the manner above referred to, it will have true shoulder diameter after the rolling action just described.

Fig. 6 shows the relation of the parts just before the blank reaches the platens, and Fig. 7 illustrates the relation of the parts near the end of the planishing action. The burr 25 has been rolled down, the displaced metal being received by the final turn of the thread and forming a prolongation of the shoulder, which extends down to a thread turn of full outside diameter.

It is considered advisable to have the platens extend inwardly (downwardly) some distance beyond where the burr is encountered. Theoretically the platen surfaces are tangential to the thread crest but

if it is found that the platens tend to flatten the thread crest, the platen surfaces may be ground off along the inner edges to avoid this.

It will be noted that while the blank is passing between the platens, part of the shank is still rolling between die teeth. At this stage, however, the thread has been completely formed and the die teeth have no function except, perhaps, to guide the blank.

As the moving die reaches the end of its rolling stroke the blank reaches the end of the stationary die and can drop out, to be collected as desired. The moving die then makes an idle return stroke to initial position, thus completing the cycle of operations for one blank.

Referring back to the blank, it is noted that the bevel above mentioned need not necessarily be a true bevel. That is, the surface may be frustro-conical or may be slightly rounded. What is desired is a gradual step down from shoulder to shank of such dimension that the dies will upset such a burr as can be worked into the shoulder to prolong the same as described. For convenience, however, the term bevel has been used. The angle of the bevel is not the same for all blanks. Generally speaking, the angle of bevel varies with the diameter of blank and with the depth of thread to be formed. As it is difficult, even with these values known, to fix a standard, it is considered advisable to adopt a given bevel and make a trial run. It has been found that for screws varying in diameter from 1/4″ to 7/8″ a suitable range of included bevel angles is from 20° to 30°. This range provides a starting point for a given production run, correction being made, if necessary, after a trial run, as later described. As the difference in shoulder and shank diameter for a given size screw and given dies is fixed, the fixing of the bevel angle, of course, determines the axial length of the bevel.

The angle of chamfer of the die teeth varies, generally speaking, with the angle of the bevel. For the above mentioned range of screws, a suitable range of chamfer angle is 25° to 35°. As a starting point for a given run, the die blocks are conveniently formed so that the blank is positioned in rolling to cause the threading to extend about two thirds of the way up the bevel.

As an example, the following dimensions and relations have been found suitable for the production of 1/2″ steel cap screws, all figures being approximate: diameter of shank of blank, 7/16″; diameter of shoulder (after machining), 1/2″; axial length of bevel, 5/32″ (this gives an included bevel angle of about 24°); length of shoulder of blank, 28/64″, varying slightly at different points around the circumference of the blank; angle of chamfer of die teeth, 30°; width of plain surfaces (62, 63) separating teeth from positioning ledges, 13/32″ (this allows for a blank jump of about 1/8″); diameter of shoulder and thread crest of screw produced, 1/2″; length of shoulder of screw produced 1/2″ to 33/64″ at opposite point in circumference.

While the shoulder of a given standard size should have the standard length at all points, a slight overlength at some points is immaterial. Variation, such as that above mentioned from a given shoulder length to a slight overlength is also found in cut thread products.

As unknown variables, such, for example, as the nature and condition of the stock used, may cause a slight deviation in results, it may be necessary to make a readjustment following a trial run. This may be done, for example, by changing the angle of the bevel of the blank and of the chamfer of the dies, if they are chamfered. Or it may be accomplished by a variation in the axial position of the blank with respect to the die teeth. That is, if the bevel of the blank is too long for a given die, too great a burr is formed. This may be corrected by regrinding the die teeth to change the angle of chamfer, or by using other blanks. If the bevel of the blank is too short for a given die, there is not enough of a burr formed. This may be corrected by new dies, new blanks, or by grinding down the ledges of the dies (60, 61) so as to so position the blanks that the threading extends further up the bevel, more metal thus being upset into the burr.

To review the operations described: From the rough blank of Fig. 9, an intermediate blank as shown in Fig. 10 is formed, having a shoulder 23^b finished as to diameter but short as to length. With the movable die 36 drawn back, a blank is suspended by its head from ledges 60, 61. Upon the advance of die 36 the blank is rolled between the two dies, the teeth of which upset the metal into the form of a thread, the metal being displaced outwardly into the die grooves to give a thread crest diameter equal to the shoulder diameter. During the threading the die teeth upset some of the metal of the blank into the form of a burr, beyond the final turn of the thread. Near the end of the stroke of the moving die the upper end of the blank is rolled between the platens or planishing dies 70, 73. These roll down the burr to shoulder diameter, working the metal into the shoulder to elongate it which carries the shoulder down to a thread crest of full outside diameter and to the desired length.

With the method and apparatus described, it is possible to utilize the economical step of threading the blank by die rolling, at the

same time producing a cap screw the thread of which terminates regularly and definitely at the shoulder so that the screw has the appearance and strength of a cut-thread product. Further, the shoulder is properly finished and is true to size.

What I claim is:

1. The herein described method of producing cap screws and the like which comprises forming a blank having a shoulder and a shank smaller in diameter than the shoulder, and having a bevel between shoulder and shank, die-rolling the shank and part of the bevel to thread the same, the metal flowing outwardly to form the thread crest, causing part of the metal adjacent the end of the shoulder to be upset in the form of a ridge or burr beyond the final turn of the thread, and removing said burr.

2. The herein described method of producing cap screws and the like, which comprises forming a blank having a shoulder and a shank smaller in diameter than the shoulder, and having a bevel between shoulder and shank, die-rolling the shank and part of the bevel to thread the same, the metal flowing outwardly to form the thread crest, causing part of the metal adjacent the end of the shoulder to be upset in the form of a ridge or burr beyond the final turn of the thread, and rolling down said burr to shoulder diameter.

3. The herein described method of producing cap screws and the like, which comprises forming a blank having a shoulder and a shank smaller in diameter than the shoulder, the shoulder being shorter than the desired shoulder, and having a bevel between shoulder and shank, die-rolling the shank and part of the bevel to thread the same, the metal flowing outwardly to form the thread crest, causing part of the metal adjacent the end of the shoulder to be upset in the form of a ridge or burr beyond the final turn of the thread, and working the upset metal into the shoulder to elongate it.

4. The herein described method of producing cap screws and the like, which comprises forming a blank having a shoulder and a shank smaller in diameter than the shoulder, the shoulder being shorter than the desired shoulder, and having a bevel between shoulder and shank, die-rolling the shank and part of the bevel to thread the same, the metal flowing outwardly to form the thread crest, causing part of the metal adjacent the end of the shoulder to be upset in the form of a ridge or burr beyond the final turn of the thread, working the upset metal into the shoulder to elongate it, and at some stage in the production, machining the shoulder to desired diameter.

5. The herein described method of producing cap screws and the like, which comprises forming a blank having a shoulder and a shank smaller in diameter than the shoulder, and having a bevel between shoulder and shank, machining the shoulder to size, die-rolling the shank and part of the bevel to thread the same, the metal flowing outwardly to form the thread crest, causing part of the metal adjacent the end of the shoulder to be upset in the form of a ridge or burr beyond the final turn of the thread, and rolling down said burr to shoulder diameter.

6. The herein described method of producing cap screws and the like, which comprises forming a blank having a shoulder and a shank smaller in diameter than the shoulder, the shoulder being shorter than the desired shoulder, and having a bevel between shoulder and shank, machining the shoulder to size, die-rolling the shank and part of the bevel to thread the same, the metal flowing outwardly to form the thread crest, causing part of the metal adjacent the end of the shoulder to be upset in the form of a ridge or burr beyond the final turn of the thread, and working the upset metal into the shoulder to elongate it.

7. The herein described method of producing cap screws and the like, which comprises forming a blank having a shoulder and a shank smaller in diameter than the shoulder, the shoulder being shorter than the desired shoulder, die-rolling the shank to thread the same, upsetting some of the metal beyond the final turn of the thread, and working said upset metal to form an elongation of the shoulder.

8. The herein described method of producing cap screws and the like, which comprises forming a blank having a shoulder and a shank smaller in diameter than the shoulder, die-rolling the shank to thread the same, causing the metal of the blank adjacent the end of the shoulder to be upset in the form of a burr or ridge, and finishing the shoulder to remove the burr.

9. The herein described method of producing cap screws and the like, which comprises forming a blank having a shoulder and a shank of smaller diameter than the shoulder, the shoulder being of a length shorter than the length desired, machining the shoulder to size, threading the shank, and causing the shoulder to be given its desired length following the threading.

10. In the method, herein described, of producing cap screws and the like, the steps which consist in upsetting, during threading, the metal of the blank into the form of a ridge or burr beyond the final turn of the thread and then working down said burr.

11. The herein described method of producing cap screws and the like, which comprises forming a blank having a shoulder and a shank smaller in diameter than the shoulder, cutting the shoulder to desired

diameter, and die-rolling the shank to thread the same.

12. The herein described method of producing cap screws and the like, which comprises forming a blank having a shoulder and a shank smaller in diameter than the shoulder and having a bevel between shoulder and shank, and die-rolling the blank to thread the shank and part of the bevel, the shoulder and upper part of the bevel being left free during the threading operation.

13. In apparatus of the class described, and in combination, means for threading a cap screw blank and causing, during threading, the formation of a burr on the blank beyond the final turn of the thread, and means for removing the burr.

14. In apparatus of the class described, and in combination, means for threading a cap screw blank and causing, during threading, the formation of a burr on the blank beyond the final turn of the thread, and means for rolling down the burr to the diameter of the shoulder of the blank.

15. In apparatus of the class described, and in combination, means for threading a cap screw blank and causing, during threading, the formation of a burr on the blank beyond the final turn of the thread, and means for working the metal of the burr into the shoulder of the blank to elongate the shoulder.

16. In apparatus of the class described, and in combination, two complementary threading dies for threading a cap screw blank and causing, during threading, the formation of a burr on the blank beyond the final turn of the thread, two complementary planishing dies for rolling down said burr and working the metal into the shoulder of the blank to elongate the shoulder, and means for causing relative movement of the threading dies and the planishing dies.

17. In apparatus of the class described, and in combination, two complementary threading dies for threading a cap screw blank, means for positioning the blank to leave the shoulder of the blank free of the dies during threading, thereby to permit the dies to cause a burr to be formed beyond the final turn of the thread, and two complementary planishing dies for rolling down said burr and working the metal into the shoulder of the blank to elongate the shoulder.

18. In apparatus of the class described, and in combination, two complementary threading dies for threading a cap screw blank, and means for positioning the blank to leave the shoulder of the blank free of the dies during threading, thereby to permit the dies to cause a burr to be formed beyond the final turn of the thread.

19. In apparatus of the class described, and in combination, two complementary threading dies for threading blanks comprising a shoulder, a shank of smaller diameter than the shoulder, and a bevel between shank and shoulder, said dies having the trailing ends of their teeth chamfered, means for causing relative movement between said dies, whereby a blank may be rolled between the same, and means for positioning a blank whereby the upper part of the bevel and the shoulder are free of the threading dies.

20. A threading die comprising a block having a series of parallel oblique teeth the trailing ends of which are chamfered and a ledge parallel to the line of termination of the chamfered teeth for positioning a blank, the surface of the block between said ledge and the teeth being in a plane below the plane of the bottoms of the die teeth.

21. In combination, a threading die comprising a block having a series of parallel oblique teeth the trailing ends of which are chamfered and a ledge parallel to the line of termination of the chamfered teeth for positioning a blank, the surface of the block between said ledge and the teeth being in a plane below the plane of the bottoms of the die teeth, and a planishing die having its planishing surface substantially in the plane of the bottoms of the die teeth.

22. In combination, a threading die comprising a block having a series of parallel oblique teeth the trailing ends of which are chamfered and a ledge parallel to the line of termination of the chamfered teeth for positioning a blank, the surface of the block between said ledge and the teeth being in a plane below the plane of the bottoms of the die teeth, the block being cut away to form a recess adjacent the rear end thereof in line with said surface but wider than the latter, and a planishing die located in said recess and having its planishing surface substantially in the plane of the bottoms of the die teeth.

23. In combination, a threading die comprising a substantially rectangular block having a series of parallel teeth, and a planishing die associated with said block adjacent one rear corner, the width of said planishing die being such as to extend both outwardly and inwardly beyond the line of termination of the die teeth, and its planishing surface being substantially in the plane of the bottoms of the die teeth.

24. In apparatus of the class described, and in combination, two complementary threading dies for threading a cap screw blank, means for positioning a blank so that its shoulder is beyond the die teeth to be free of the dies, and two complementary planishing dies spaced apart a distance substantially equal to the distance between the planes of the bottoms of the die teeth and

associated with the threading dies to act on the shoulder of the blank after the blank has been threaded.

25. A thread rolling die comprising a block having a series of parallel teeth which terminate short of one of the edges of the block, and having a surface, between the line of termination of the teeth and the edge of the block, which lies in a plane below the plane of the bottom of said teeth.

In testimony whereof, I have hereunto set my hand.

FREDERICK J. SENIOR.