

W. G. ALLEN.  
MANUFACTURE OF WOOD SCREWS.

APPLICATION FILED JAN. 30, 1906.

2 SHEETS—SHEET 1.

Fig. 1.

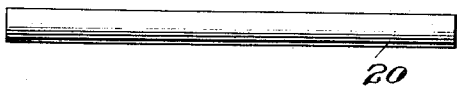


Fig. 6.



Fig. 2.

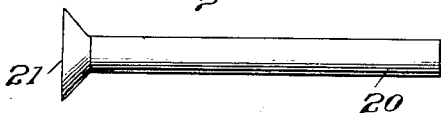


Fig. 7.

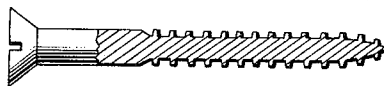


Fig. 3.

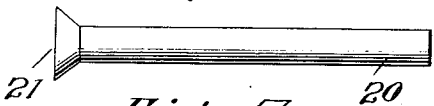


Fig. 9.

Fig. 4.

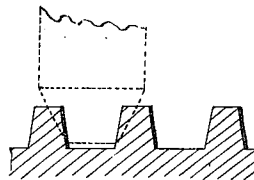
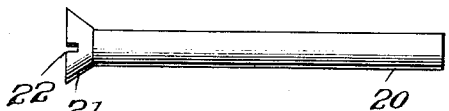


Fig. 5.

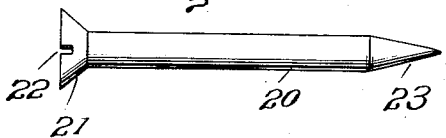


Fig. 10.

Fig. 11.

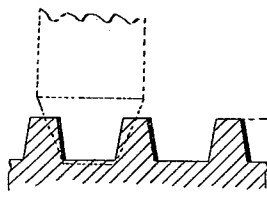
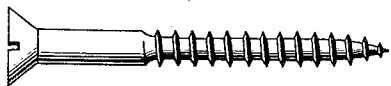


Fig. 12.

Fig. 8.



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2 SHEETS—SHEET 2.

Fig. 13.

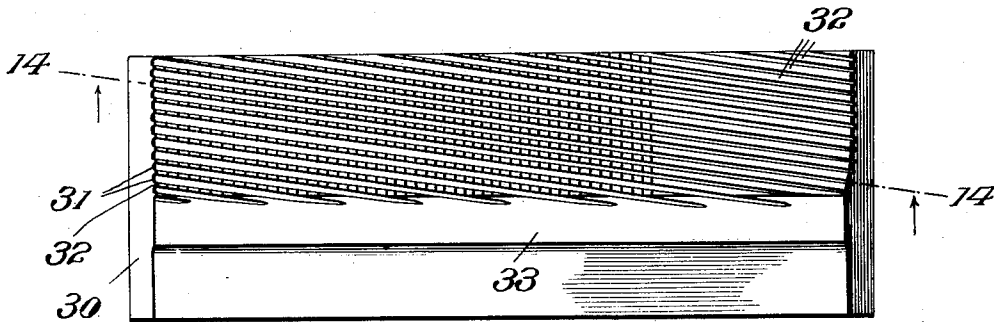


Fig. 14.

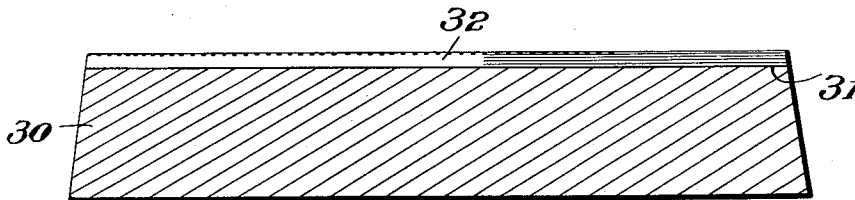
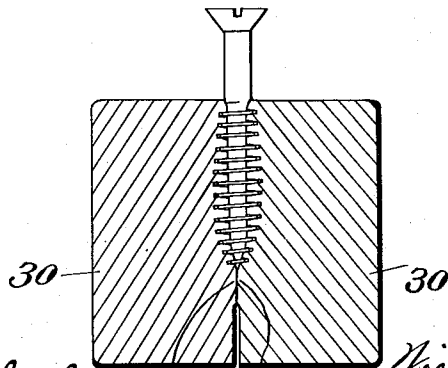


Fig. 15.



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# UNITED STATES PATENT OFFICE.

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## MANUFACTURE OF WOOD-SCREWS.

No. 877,157.

Specification of Letters Patent.

Patented Jan. 21, 1908.

Application filed January 30, 1906. Serial No. 298,730.

To all whom it may concern:

Be it known that I, WILLIAM G. ALLEN, of Hartford, Connecticut, have invented a new and useful Improvement in the Manufacture of Wood-Screws, which invention is fully set forth in the following specification.

Wood-screws of commerce are mostly what are known as "cut-screws"—*i. e.* the screw-threads are formed by the action of a cutting-tool in a screw-thread cutting machine which cuts off a portion of the metal of the blank from which the screw is formed. Extended efforts have heretofore been made to produce wood-screws having the desirable and for most uses requisite characteristics of cut-screws, at the same time avoiding the expense of the cutting. To that end various ways of forming the screw-threads by the action of relatively movable dies have been proposed—the resulting screws being commonly referred to as "rolled screws". But so far as I am aware the only "rolled screws" that have been marketed and used to any material extent have objectionable characteristics (some of which are mentioned hereafter) which render them inferior to, and hence unable to compete with, "cut-screws" for most uses.

Among the disadvantages of "cut-screws" I may mention the following:—The thread-cutting is a time-consuming and expensive operation, it being necessary in the case of relatively small screws to cause the cutting-tool to pass over the work approximately from six to eight times, and in the case of relatively large screws approximately in some cases as high as twenty to twenty-five times, before the proper size and shape of thread is formed. This also limits the production of each screw-cutting mechanism to a small number of screws per minute. To facilitate the cutting and reduce the injury to and wear upon the cutting-tools, it is necessary to form the screw-blanks of a hard brittle metal which cuts freely. On the other hand, the use of such hard metal adds to the difficulties of swaging the heads on the blanks and causes more wear upon the swaging tools than a softer metal. Furthermore, as the swaging of the head further hardens the metal of which the head is formed, this additional hardening in the case of an originally hard metal blank produces excessive hardness and brit-

teness, rendering the head liable to split and break (particularly through the slot) in the operation of cutting the thread and also in subsequent use, it being understood that in the thread-cutting operation the blank is turned against the point of a relatively fixed cutting-tool by the engagement with the slot of a part of the mechanism resembling the point of a screw-driver. As is well known, in the case of cylindrical blanks of metal, such as those from which screws are made, the central unworked and unforged portion of the metal is of inferior strength compared with the exterior or surface portion which has necessarily been worked or forged in the operation of forming the rod or wire from which the blanks are cut. In the formation of "cut-screws" it is this stronger surface portion of the metal which is principally removed and wasted, leaving the threads formed by cuts across the fiber of the metal, said fiber extending longitudinally of the blank.

Among the disadvantages of "rolled-screws" I may mention the following: In the heretofore proposed methods of forming the threads on such screws (the object being to effect this at one operation) a blank cut to proper length is introduced cold (*i. e.*, not heated to soften) between two dies relatively movable in a longitudinal direction but which are rigidly held with the working-faces a fixed distance apart. Said working-faces have heretofore been provided with a series of oblique or diagonally extending ribs with intervening grooves, the face of each rib gradually widening from its front end toward its rear or finishing end while the intervening grooves gradually widen and become shallower in the reverse direction. At the finishing end of the dies the grooves correspond in depth and shape in cross-section to the height and shape in cross-section of the screw-thread to be formed thereby on the screw-blank. As the result of this configuration of the grooves and ribs of the dies, and of pressure applied thereby upon the shank portion of the screw-blank, the ribs are forced into the metal of the blank, compressing and displacing it and causing it to be forced up into the grooves between the ribs, thereby raising upon the blank a spiral rib of greater diameter than the original diameter of the shank upon which it is formed.

For the formation of an approximately perfect or satisfactory screw-thread it is necessary that the rib or thread shall exactly and completely fill the grooves at the finishing ends of the opposing dies. As already stated, while the dies are relatively movable longitudinally of each other, they are rigidly maintained at a constant distance apart; in fact these dies are commonly made to bear and slide upon each other at one side of the thread-forming portions of their surfaces. The wire stock of commerce from which wood-screw blanks are commonly cut varies slightly in size at different portions of its length and in different rolls of wire, resulting in corresponding variations in the diametrical dimensions of different blanks. The cost of wire stock of exactly uniform size would be prohibitive in wood-screw manufacture. But the greatest variation in the size of blanks probably results in the operation of heading preceding the rolling of the thread. In this operation the straight metal blank is held at one end in an opening (formed partly in each of two die jaws) closed at one end and counter-sunk or flared at its other end corresponding to the shape of screw-head to be formed. Blows upon the projecting end of the blank upset the same and form a head conforming to the flaring die opening. As is well known, this die-opening rapidly wears, and to constantly renew the dies would be prohibitively expensive. It follows that the blows which form the head also shape the shank of the blank to the worn and enlarged shape of the die-opening. These unavoidable variations in the sizes of blanks result in imperfections in and frequently total destruction of, the screw-thread raised by the dies, also frequent injury to the dies. If the blank varies in excess of the required dimensions the displaced metal will fill the grooves before their shallow or finishing ends are reached, resulting in excessive compression causing the blank to slide between the die-faces and injuring or destroying the screw-thread. This sliding of the blank frequently clogs the dies with consequent delays in operation, and also often injures the dies. If the dimensions of the blank are less than required (variations of one or two thousandths of an inch are detrimental) the metal raised in the thread fails to completely fill the die-grooves at their finishing ends. The screw-threads formed under these conditions have rough and uneven peripheral edges. But "rolled screws" of commerce possess some points of advantage over the well-known cut-screws; for example, in rolling, blanks of softer metal are used and the swaging of the head does not weaken the latter by imparting excessive hardness. The rolling of the thread consolidates, toughens and hence strengthens the normally weaker interior portion of the

metal at the same time maintaining an unbroken relation between the thread and the body of the screw and also retains the strong surface portion of the blank with the fiber of the metal continued through all the undulations of the threaded surface. On the contrary, in cut-screws this stronger surface portion is mostly cut away and the screw weakened by having the threads formed on the under portion of inferior metal. Rolled-screws can be more rapidly and cheaply made than "cut-screws." On the other hand, the more perfectly formed threads, not exceeding the diameter of the smooth shank portion adjoining the head, gives to cut-screws an advantage which makes them preferable for most uses over the rolled screws of commerce, in which latter the threads are more or less imperfect and exceed in diameter the smooth shank portion adjoining the head, said smooth portion consequently loosely fitting the opening through which the larger thread portion has entered.

It is my particular object to provide a wood-screw possessing especially those desirable characteristics of cut-screws which at present render the latter superior for most uses to rolled screws of commerce; it is also my object to embody in such a screw those desirable characteristics of rolled screws which render the latter in some respects superior to the well-known cut-screws, and to further provide a wood-screw possessing points of superiority not present in either the cut or rolled screws of commerce.

It is my further object to improve upon methods heretofore known of forming screw-threads upon articles of commerce such as screws, bolts and the like, whereby this work may be done not only much cheaper (the time, labor and wear upon tools and machinery being minimized), but better than by the known cutting methods.

With these and other objects in view my invention is an improved process of manufacturing wood-screws and analogous articles, and particularly of forming the screw-threads thereon.

In accordance with my invention as preferably followed in making wood-screws, I first roll the groove between the threads and subsequently impart the desired form and finish to the thread. Preferably the step of giving the thread its final form is done by cutting, though this may be done by grinding, by a second rolling operation, or otherwise. I prefer however to do this by cutting and I thus obtain at least to a maximum degree, all of the advantages of both methods as heretofore practiced while eliminating or minimizing their disadvantages. The rolled thread is made sufficiently large to permit removal of all irregularities and proper shaping of the thread by the cutting. Consequently as the shape of the die-grooves

is not relied upon to impart finished shape to the screw-thread it is not necessary that the raised threads shall at any time in the rolling operation exactly and completely fill the grooves in order to get a properly finished thread. On the contrary, in the improved dies preferably employed the grooves are made of such depth as not to be filled by the threads at any time during the rolling operation, whereby I avoid difficulties above explained with reference to screw-thread rolling methods heretofore proposed. While it is believed that the most satisfactory and economical results may be obtained by first rolling the thread, I may also—especially in the formation of threads on articles other than wood-screws, such as bolts, where saving of expense and rapidity of production are not so essential—do that part of the work by cold forging methods such as cold-swaging. In those other methods of cold forging it is also essential to the obtainment of the best and satisfactory results, that the grooves of the die members shall be of such depth as not to be filled by the thread.

The above and other important features will be more fully explained in connection with the accompanying drawings, showing the invention applied to a wood-screw, although as will be readily appreciated, the improvements are also applicable to other articles having a screw-thread or threads thereon.

Figures 1 to 5 illustrate a series of well-known steps or operations upon screw-blanks preparatory to forming a screw-thread thereon—Fig. 1 showing a blank as cut from wire or other stock, Fig. 2 the blank of Fig. 1 having a head swaged thereon, Fig. 3 the same blank with the head shaved or trimmed, Fig. 4 the same with the head slotted, and Fig. 5 the same pointed and with the head again trimmed to remove burs or rough edges formed in slotting. Fig. 6 shows the blank of Fig. 5 having a screw-thread rolled thereon in accordance with the present invention. Fig. 7 illustrates the screw of Fig. 6 with the peripheral edge of the thread cut or shaved off to remove any roughness, irregularities and unevenness, and to reduce the thread to the desired diameter. Fig. 8 shows the screw of Fig. 7 with the thread sharpened by cutting or trimming its edges. Fig. 9 illustrates one form of cut by which the thread of Fig. 7 may be sharpened to the shape shown in Fig. 10. Fig. 11 illustrates another form of cut by which the thread of Fig. 7 may be sharpened to the shape shown in Fig. 12. Fig. 13 is a plan view of one of the improved dies used in rolling the screw-thread. Fig. 14 is a section on line 14 of Fig. 13, and Fig. 15 is a transverse section through two dies and a screw in the operation of rolling a thread upon the latter.

In the manufacture of wood-screws, I pre-

erably form the blank 20 of Fig. 1 of relatively soft metal—much softer than that used for blanks of ordinary cut-screws. The formation upon this blank of head 21, Fig. 2, by the well-known method of swaging or upsetting, toughens, densifies and hardens the metal of which the head is formed without giving excessive hardness and brittleness and consequent liability of splitting and breaking of the head, as results in the case of relatively hard blanks used in making the ordinary cut-screws. The head is next trimmed to present a smooth surface, as shown in Fig. 3, the slot 22 then cut as shown in Fig. 4, and the head again trimmed to remove burs or rough edges formed in cutting the slot. Point 23 is next formed on the blank, as shown in Fig. 5. Although I prefer to carry out these steps in advance of the operation of rolling the screw-thread, which operation is about to be explained, the order of the steps may be changed as found most convenient; for example, the steps of forming, trimming and slotting the head may follow the rolling of the thread. Upon the blank in any suitable form and while cold (*i.e.*, not heated to soften), I next roll a thread such as shown in Fig. 6. In rolling this thread the best results may be obtained by employing my improved dies 30, 30, such as shown in Figs. 13, 14 and 15. These dies, which are preferably exact duplicates, resemble in some respects dies heretofore used in rolling screw-threads. They have a series of oblique substantially parallel grooves 31, each gradually narrowing from the end at which the blank enters (left-hand end, Fig. 13) to the end at which said blank leaves the bite of the dies (right-hand end, Fig. 13). These grooves are separated by ribs 32 gradually tapering in a direction opposite that of the taper of the grooves. An important difference over dies heretofore known for such work is that the grooves, preferably of uniform depth, are throughout their length of such depth as not to be filled at any point by the screw-thread raised on the screw by the rolling operation, not even at the ends of the dies (right-hand end, Fig. 13) which last act on the screw-thread and when the blank is over size. Thus in Fig. 15, intended to show the relative position of two dies at or near the finish of their operation upon a screw, it will be noticed that the grooves are somewhat deeper than the thread on the screw. From this peculiarity important results are obtained; slight variations in the size of blanks do not produce detrimental or injurious results upon the threads or upon the dies, as previously explained with reference to rolling methods heretofore practiced. Furthermore, I avoid excessive compression of the threads resulting in objectionable hardness, brittleness and splitting of the metal of which they are formed, this being a difficulty frequently

encountered where the thread must completely fill the grooves. The formation of the thread by rolling does however result in toughening, densifying and hardening the metal of the threaded portion of the screw, and this, particularly in the case where the original blank is of relatively soft metal, facilitates any subsequent cutting or trimming of the threaded portion.

Another important feature of the dies is the transverse notches across the edges of ribs 31, as shown in Figs. 13 and 14, thus providing teeth which at the start and during a portion of the rolling operation engage the screw-blank to insure rotation of the blank on its axis during the relative longitudinal movement of the dies. Damage to the screw and dies resulting from sliding of the blank, *i.e.*, its failure to rotate on its axis while the dies are in movement,—is thus avoided. These notches do not extend to the end of the die which last acts upon the screw, the edges of the ribs at this portion being smooth, so that as the screw leaves the dies the bottom of the groove of the thread is smooth. As is usual, the relative positions of the dies 30, 30 is determined by sliding contact between flat portions 33 of the die block faces. Instead of die-blocks such as shown, I may if preferred, employ rotary disks or rollers having suitable curved die-surfaces preferably embodying the important characteristics of this invention.

On some types of screw-threaded articles, particularly those for engagement with an already formed interiorly screw-threaded opening, the thread may in some instances be used as formed by the rolling dies without further finishing. But when a thread of uniform and regular diameter and having a smooth regular peripheral edge is desired, as is usual in the case of wood-screws, I cut or trim off the peripheral edge of the rolled thread of Fig. 6, reducing it to the form and diameter shown in Fig. 7. This operation may be rapidly accomplished.

When in addition to the characteristics last mentioned, a thread of less thickness, or more tapered, or having a sharpened edge is desired, as is also usually the case in wood-screws, the rolled screw-thread of Fig. 7 having its peripheral edge cut, is further cut to any desirable shape (such as shown in Figs. 10 and 12) having a sharpened edge. To cut the thread to the shape shown in Fig. 10, I employ a tool having a cutting-edge of the shape shown in dotted lines, Fig. 9, which in passing from end to end of the screw (one cutting is usually sufficient) cuts metal from both sides of the thread without removing any metal from the bottom of the groove between the spirals of the thread. To cut the thread to the shape shown in Fig. 12 I may employ a tool having a cutting-edge of the shape shown in dotted lines, Fig. 11, which

trims the sides of the thread and preferably the bottom of the groove. With the object of still further minimizing the cutting where a sharpened thread, such as shown in Figs. 10 and 12 is desired, I may omit the first cutting operation for shaving off the peripheral edge of the rolled thread, and rely upon one cutting operation to reduce the rolled thread (Fig. 6) to its sharpened form.

My improved process, as specially designed for the manufacture of wood-screws, embodies as its principal feature the formation of the screw-thread by rolling (preferably in dies having grooves of such depth as not to be filled by the thread) followed by a finishing, shaping or sizing of the thread by cutting. These steps in conjunction with the usual steps for forming the head result in a wood-screw possessing characteristics by which it may be distinguished from other wood-screws. The unthreaded portion of the shank adjacent to the head, not having been worked, is relatively soft as compared to both the head (the metal of which has been hardened and densified in the formation of the head) and the threaded portion (the metal of which has been hardened and densified by the rolling of the thread). All of the metal in the thread, having been raised from the blank and thus worked, is harder and more dense than in its original form, and consequently harder than the unthreaded portion of the shank of the finished screw. Consequently, even though a portion of the rolled thread be cut away in finishing or shaping, the final thread is left formed in metal which has been hardened and densified by the rolling and which is harder and more dense than the metal at the unthreaded portion. This increase in density and hardness of the threaded portion renders it practically as strong as the unthreaded portion and the screw of approximately uniform strength from head to point. These characteristics are not present in the heretofore known "cut-screw" for the reason that in the latter the metal of the thread and the unthreaded portion of the blank are of their original density and hardness, the threaded portion being further weakened by removal and cutting across the fiber of the stronger surface metal; it results that the threaded portion is much weaker than the unthreaded part. Furthermore, as compared with the heretofore known "rolled-screw" the thread of my improved screw exhibits spiral or volute lines made by the action of the cutting-tool or tools in shaping, sizing or finishing the thread, whereas no such lines appear on the thread of the ordinary "rolled screw". In those cases in which the entire surface of my rolled thread is not cut the lines of cut appear only on the cut portion. For example, if the thread be used in the form shown in Fig. 7, the lines of cut will appear only at the

periphery of the thread; if used in the form shown in Fig. 10, the lines of cut will appear only on the sides of the thread and not at the bottom of the groove. When my thread has these last mentioned characteristics it is further distinguishable from "cut-screws" in which the lines of cut cover the entire surface of the threaded portion, and from "rolled screws" in which no lines of cut appear on the threaded portion.

Articles other than wood-screws, having threads formed thereon by my combined rolling and cutting operation, will also exhibit or disclose the distinguishing characteristics above explained, or some of them. My invention also embraces the improved method of rolling a thread in which the latter at no time fills the die-grooves, whether followed by a cutting of the thread or not. Furthermore, I do not limit myself to one or more cutting operations to finish the thread, though as before explained, it is desirable to minimize the same.

While reference has been particularly made to the formation of a single thread (as is customary in most wood-screws) it is to be understood that the invention is equally applicable to the simultaneous formation of two or more parallel threads.

I am aware that prior to my invention it has been proposed (as for example, in U. S. Patent No. 54,687, dated May 15, 1866) to forge screw-threads on bolts while hot by feeding the hot blank between cooperating hammer and anvil dies, and for some purposes to pass the bolt thus formed when cold through finishing-dies, it being said to be only necessary to take off a very small cut to give the bolt a fine bearing surface. But this is a materially different method from mine wherein the thread is first formed by cold forging.

What I claim is:—

1. In the manufacture of screws and analogous screw-threaded articles, the process of forming the screw-thread consisting in cold-forging the thread on the article, and then bringing said forged thread to the desired dimensions by cutting.

2. In the manufacture of screws and analogous screw-threaded articles, the process of forming the screw-thread consisting in cold-rolling a thread on the article, and then bringing said cold-rolled thread to the desired dimensions by cutting.

3. In the manufacture of screws and analogous screw-threaded articles, the process of forming the screw-thread consisting in cold-rolling a thread on the article, and then bringing said cold-rolled thread to the desired diameter by cutting.

4. In the manufacture of screws and analogous screw-threaded articles, the process of forming the screw-thread consisting in for-

ing on the article a thread of larger diameter than the original diameter of the part of the article on which it is forged, and then bringing the thread to the desired dimensions by cutting.

5. In the manufacture of screws and analogous screw-threaded articles, the process of forming the screw-thread consisting in rolling on the article a thread of larger diameter than the original diameter of the part of the article on which it is rolled, and then bringing the thread to the desired dimensions by cutting.

6. In the manufacture of screws and analogous screw-threaded articles, the process of forming the screw-thread consisting in cold-rolling on the article a thread of larger diameter than the original diameter of the part of the article on which it is rolled, and then bringing the thread to the desired dimensions by cutting.

7. The process of forming a screw-thread on screws and analogous articles, consisting in cold-forging a thread without limiting expansion of the thread in a radial direction in the forging operation.

8. The process of forming a screw-thread on screws and analogous articles, consisting in radially indenting the article to form the groove separating convolutions of the thread, and throughout said indenting operation leaving that portion of the article along the line of the thread free to unlimited radial expansion.

9. The process of forming a screw-thread on screws and analogous articles, consisting in radially indenting the article to form the groove separating convolutions of the thread, and throughout said indenting operation leaving that portion of the article along the line of the thread free to unlimited radial expansion, and then cutting the thread thus formed to finish the same.

10. The process of forming a screw-thread on screws and analogous articles, consisting in indenting the article by rolling to form the groove separating convolutions of the thread and throughout this operation leaving that portion of the article along the line of the thread free to unlimited radial expansion.

11. The process of forming a screw-thread on screws and analogous articles, consisting in indenting the article by rolling to form the groove separating convolutions of the thread and throughout this operation leaving that portion of the article along the line of the thread free to unlimited radial expansion, and then cutting the thread thus formed to the desired dimensions.

12. The process of manufacturing screws, consisting in forging a head and cold-rolling a thread on a suitable blank, and then bringing the thread to the desired dimensions by cutting.

13. In the manufacture of screws and analogous screw-threaded articles, the process which consists in cold-forging a screw-thread on the article, and then removing material  
5 from said forged thread to bring it to the desired dimensions.

In testimony whereof I have signed this

specification in the presence of two subscribing witnesses.

WILLIAM G. ALLEN.

Witnesses:

FREDERICK A. HOLTON,  
W. B. KERKAM.