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Patented Aug. 15, 1899.

F. G. ECHOLS.  
MACHINE FOR COLD ROLLING.

(Application filed Nov. 4, 1898.)

(No Model.)

3 Sheets—Sheet 1.

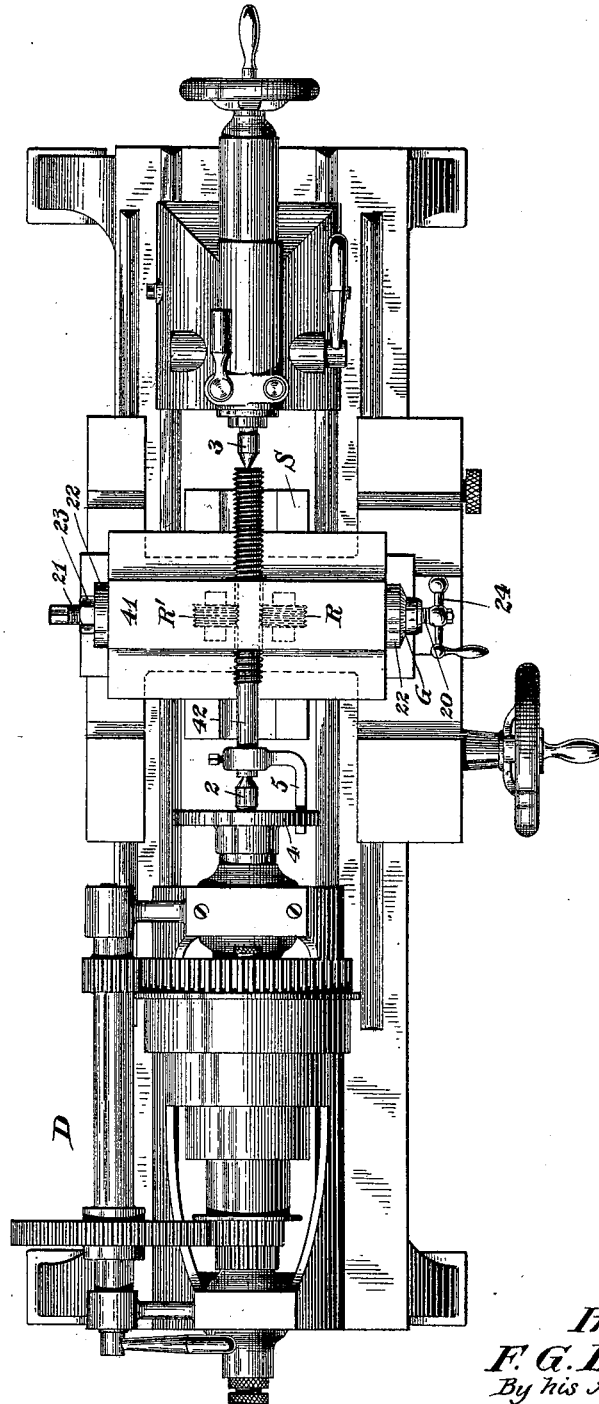


Fig. 1.

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By his Attorney

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3 Sheets—Sheet 2.

Fig. 2.

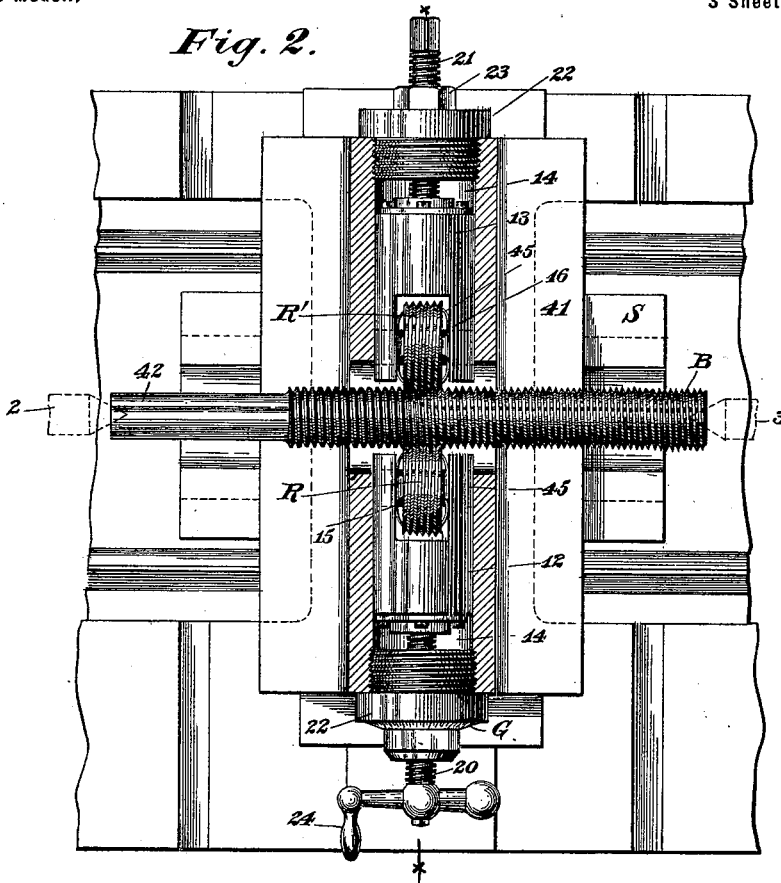
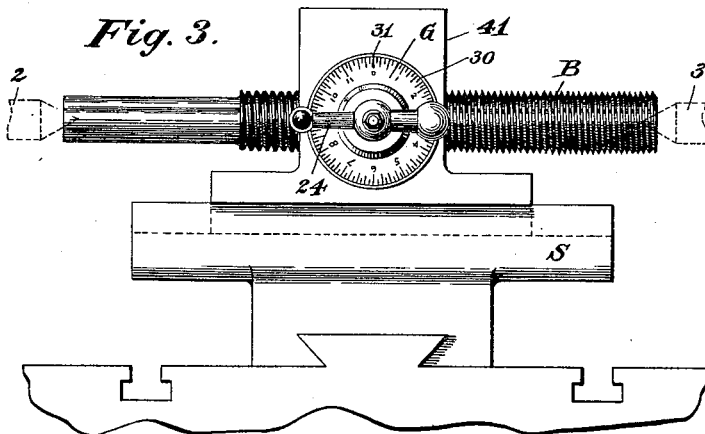


Fig. 3.



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3 Sheets—Sheet 3.

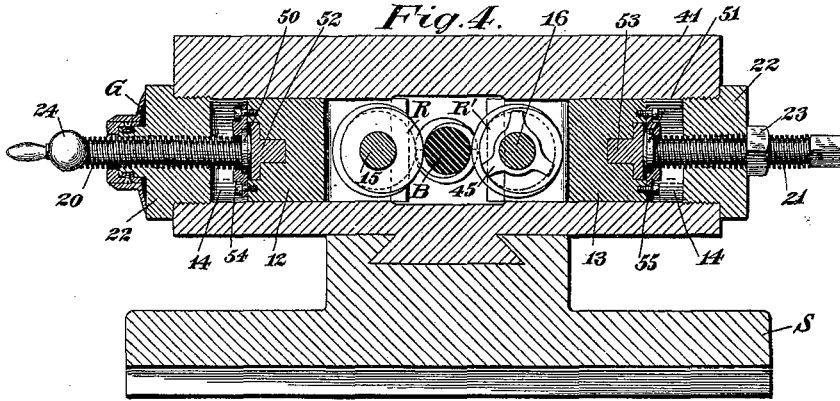


Fig. 5.

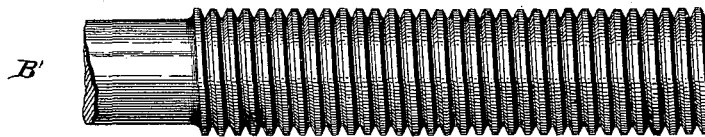
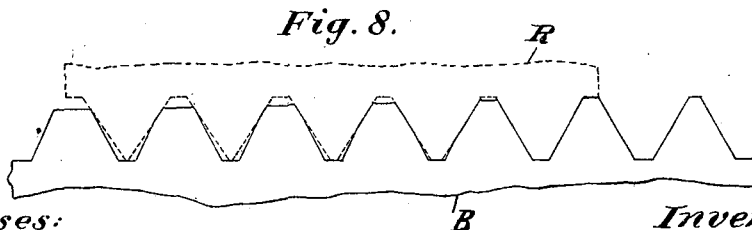
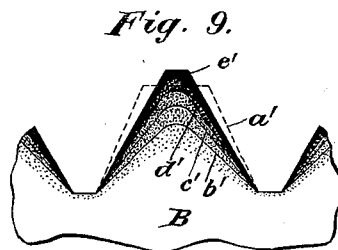
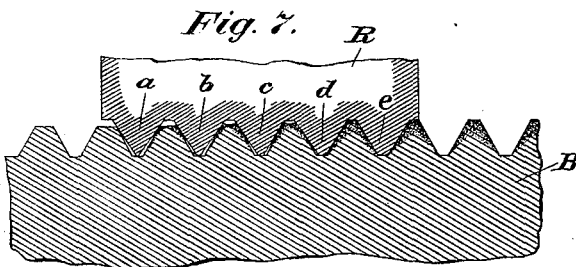
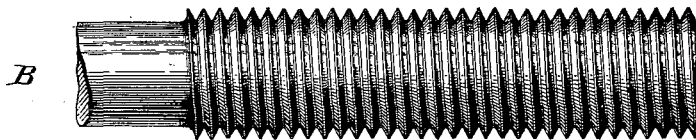


Fig. 6.



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# UNITED STATES PATENT OFFICE.

FRANK G. ECHOLS, OF HARTFORD, CONNECTICUT.

## MACHINE FOR COLD-ROLLING.

SPECIFICATION forming part of Letters Patent No. 631,159, dated August 15, 1899.

Application filed November 4, 1898. Serial No. 695,431. (No model.)

*To all whom it may concern:*

Be it known that I, FRANK G. ECHOLS, a citizen of the United States, residing in Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Machines for Cold-Rolling Screw-Threads, of which the following is a specification.

My invention relates to machines for cold-rolling to a precisionized form threads cut in the surface of a blank; and the object thereof is to produce a substantially perfect thread the metal of which is densified or compacted as hereinafter described.

In the embodiment of the invention illustrated a machine is shown for cold-rolling the cut threads of a blank to be employed in the manufacture of screw-cutting taps, but the machine is not limited to this use, as it may be employed for cold-rolling or forming other kinds of thread or with slight modifications in the manufacture of various tools or objects of metal in which accurate and hardened working faces are essential.

In the usual practice of cold-rolling a screw-thread directly upon a bar of metal what is termed the "skin" of the material is not removed, and said skin, which is quite thin, is so affected by the cold-rolling operation that the thread will become warped or distorted during the process of tempering, thereby seriously weakening the surface or cutting edge of the article and also materially impairing its quality of precision. In my improved process, however, the primary cutting of the thread or surface of the metal removes this weak skin, and the blank is therefore in better condition for the subsequent rolling operation by which the molecules of metal are compacted into a solid and dense mass, the result being that the working surface of an article produced in this manner will not become distorted or warped while being tempered and that the finished article will be in as nearly a precisionized form as can be secured mechanically.

My improved machine comprises one or more thread-forming rolls, which are preferably rotatably supported, and in the present case two rolls are represented, mechanical means being employed for sustaining the blank while it is being subjected to the rolling

operation. These rolls are duplicates, and they should be of substantially the same diameter, so that they will uniformly rotate, and said rolls are preferably mounted for yielding movement longitudinally, whereby the threads upon the periphery thereof may automatically find or seat themselves in the grooves between the threads of the blank.

In the drawings accompanying and forming part of this specification, Figure 1 is a plan view of my invention shown as applied to an ordinary turning-lathe. Fig. 2 is a horizontal plan view, partly in section, showing the rolls in operation upon a blank with cut threads thereon. Fig. 3 is a side view showing a blank supported between the centers of the lathe and illustrating an attachment by which the position of the rolls with relation to said blank may be accurately determined. Fig. 4 is a vertical section taken on line  $xx$  of Fig. 2. Fig. 5 is a view of the blank with a cut thread before it has been cold-rolled. Fig. 6 is a view of the finished blank having a cut thread cold-rolled. Fig. 7 is a detail view in section, showing the action of one of the rolls upon the blank. Fig. 8 is a diagrammatic view, on an enlarged scale, showing the same action, and Fig. 9 is a diagrammatic view showing by dotted lines the original form of the thread and by stippling the changes in form and in the densification of the metal during the cold-rolling operation.

Similar characters designate like parts in all the figures of the drawings.

For convenience in demonstrating the nature of my invention I have illustrated the same applied to a metal-turning lathe of ordinary construction, in which case the blank to be operated upon is mounted between the head and tail centers of said lathe, although it is obvious that the invention is not limited to the character of means shown for supporting the same, it being adapted for use with various classes of machines.

The lathe includes the usual live and dead centers 2 and 3, between which the blank, as B, is supported, and as I prefer to rotate said blank while cold-rolling the same the necessary motion is transmitted thereto from the live spindle or center 2 through the face-plate 4 and dog 5. It is evident that the

blank B, which is illustrated as a tap-blank, may be otherwise supported by the lathe and also differently rotated, and also that the blank may be held stationary and the rolls  
5 be caused to revolve around and travel along the same, if deemed desirable. The driving mechanism for the live-center is designated in a general way by D.

As hereinbefore set forth, my improved machine includes means for cold-rolling the surface of a previously-cut blank, said blank being shown as a threaded one, and to accomplish this purpose two rolls are illustrated, they being designated by R and R' and conveniently  
15 carried by section 41 of the slide S, which travels along said slide as the rolling operation progresses, the blank being rotated and its thread serving by its engagement with the threads of the rolls to advance said slide-section  
20 41 longitudinally of the blank.

I have found in practice that by my improved mode of operation a tap is produced the thread of which is of precisionized form and the molecules of metal constituting said  
25 thread are wrought together or swaged into a compact condition, the result being a finished article having a uniform and perfect thread, which has long been a great desideratum.

30 After the blank with a cut thread has been operated upon by the rolls it is to be grooved or fluted and then tempered, and in virtue of the cold-rolling operation the metal near the periphery of the blank is so dense and compact that it will not become materially warped  
35 or distorted when the tap is subjected to the hardening process.

The rolls R and R' have surfaces adapted for cold-rolling the truncated cut thread of the blank and for finishing the same, and said rolls are ground with great accuracy, whereby the reproduction of the form of the thread thereof on the tap-surface is as near  
40 precision as can be obtained. The rolls are rotatively mounted in the blocks 12 and 13, supported for sliding movement in the transverse bore or passage 14 in the section 41 of slide S and therefore may be moved toward  
45 or from each other, said rolls being shown journaled on the shafts 15 and 16, fixed in bearings in the two blocks. In working upon blanks of a uniform size the roll R' is usually held in fixed relation, while the companion roll R is moved toward or from the  
50 same, either to act upon the blank or permit the removal of the same.

To produce work of differing diameters, the block 13, carrying roll R', may be moved inward or outward, as the case may be, to accommodate the size of blank to be rolled.  
60 The roll-carrying blocks 12 and 13 are slid back and forth in the bore 14 by the screws 20 and 21, which pass through the fixed nuts 22, fitted in the opposite ends of said bore.  
65 As before stated, the block 13 is normally maintained in fixed relation to the complementary block, and for thus holding the same

a check-nut 23, in threaded engagement with the screw 21 and abutting against the fixed nut 22, is employed.

70 The screw 20 is equipped with a crank 24, by which it may be turned to adjust the block 12, and hence the roll R, toward or from the blank.

To enable the roll R to be accurately reset  
75 after a finished blank has been removed and an unfinished one placed in position, there is employed in connection with said roll an index or gage, which is preferably carried by the screw 20 and which consists in the present  
80 instance of a disk graduated in thousandths of an inch, whereby accuracy in the readjustment of said roll is insured. This index is illustrated as a disk G, which is fixed to screw 20, said disk being graduated, as at  
85 30, and the graduations being adapted to cooperate with the gage or index-mark "31" upon the outer surface of the slide-section 41 in proximity to the periphery of the disk.

In Fig. 2 the rolls R and R' are shown operating upon the blank B, and in Fig. 3 the parts are represented occupying a corresponding position, the index-mark "0" being opposite the mark "31" upon said slide-section.  
90 When the rolling operation is completed, the crank 24 is turned, thereby causing the screw 20 to move the block 12, and consequently the roll R, away from the work, so that the latter can be removed from the machine, and when a new blank of the same diameter is  
95 placed in position the crank is turned in a reverse direction until the zero-mark will be brought opposite or in line with said mark "31," thereby indicating that the block 12 is in correct position—i. e., the one it before occupied.  
100 In adjusting the roll R to a blank of a different diameter the zero-mark will of course be opposite another index, the relation shown being merely to illustrate the nature of the gage.

110 In Fig. 5 I have illustrated a blank B' having threads cut thereon in the usual manner, while the blank with the finished and precisionized cold-rolled thread is designated by B in Fig. 6. To cold-roll the blank B', it is  
115 first mounted between the centers 2 and 3 of the lathe, the slide S being in such a position that the normally stationary roll R' is clear of and is opposite an extreme end of said blank, the roll R being also out of contact  
120 with the blank and opposite said roll R'. The slide S is then moved until the thread of the roll R' is opposite the cut thread on the blank, after which the crank 24 is manipulated to cause the thread of said roll R to enter  
125 the grooves between the convolutions of the thread of the blank at a point directly opposite the roll R', this relation of the parts being represented in Fig. 4. The spindle 2 is then set in motion, and as the blank turns the  
130 threads thereof will rotate the rolls R and R', and as these rolls rotate the upper section 41 of the slide will of course be moved toward the shank 42 of the blank, the said rolls as

they turn cold-rolling the cut thread to finish and precisionize the same. When the blank has been cold-rolled, it is in the condition illustrated in Fig. 6, and to remove the same from between the two centers the crank 24 is first turned to carry the roll R away from said blank, and subsequently the slide section 41 is manipulated to carry the threads of the roll R' beyond the periphery of the rolled blank. The two rolls R and R' are of substantially the same size, and their outside diameters are the same throughout the length thereof, and the bottoms or bases of the threads of said rolls are of the same width; but the widths of the tops or apexes of said threads gradually increase from a V shape in the first convolution to a truncated form, the several threads (see Fig. 7) being designated, respectively, by *a*, *b*, *c*, *d*, and *e*, and the two first-mentioned ones being angular, while the three succeeding threads are of progressively-increased widths at their truncated portions.

The blank B' has comparatively wide truncated cut threads, said threads being reduced to the desired standard, and the diameter of the blank being increased slightly by the cold-rolling operation.

On inspection of Figs. 7 and 8 it will be observed that the first convolution *a* of the roll thread displaces the adjacent convolution of the cut thread of the blank toward the longitudinal axis thereof and at the same time radially outward and that the next convolution *b* reduces the thread of the blank to a still greater degree, this operation continuing until the thread has reached the requisite standard at the time it leaves the last convolution *e* of the roll. The apexes of the several convolutions of the thread of the blank are at first caused to assume a slightly concave form by the rolling operation; but this is wholly eliminated by the contact of said convolutions with the bottoms of the grooves of the finishing threads of the rolls, as shown in Figs. 7 and 8. The rolling operation successively densifies or compacts the metal and forces the same radially outward, the stippling in Fig. 7 of the successive convolutions of the blank B showing the manner in which the molecules of the metal are compressed. This peculiarity is also illustrated in Fig. 9, the dotted line *a'* indicating a convolution of the cut thread before it reaches the rolls R R', and the lines *b'*, *c'*, *d'*, and *e'* indicating the respective compressions of the molecules of the metal by the rolls, and the blank space between the lines *d'* and *e'* indicating the condition of the metal at the last step of the operation.

For the purpose of seating the threads of the rolls R and R' without the necessity of adjusting the slide S or the blank with relation to said rolls I prefer to make one or both of the latter yielding in a longitudinal direction.

The shafts or pins 15 and 16 are mounted in the present case for slight movement in the direction of their axes in their bearings

in the blocks 12 and 13, and said shafts 15 and 16 are encircled near their opposite ends—that is, between the rollers and their bearings—by springs, as 45, (see Figs. 2 and 4,) which bear against the blocks and the rolls, respectively, to hold the latter substantially midway between the branches of said bearings.

In positioning the roll R' with respect to the work the thread of said roll may squarely strike the thread of the blank, and as said roll is advanced the beveled surface of the cut thread of the blank, acting against the corresponding surface of the roll thread, acts as a wedge and moves the roll in the direction of its length, so that the thread of the roll can be accurately seated in the grooves of the blank, the roll R being capable of the same operation. It will be observed that the axes of the rolls are parallel with that of the blank, and for the purpose of adjusting the rolls to enable them to operate on threads of varying inclinations they are mounted for shifting movement relatively to the blank and independently of the rotative and longitudinal movements hereinbefore mentioned. This adjustment for effecting different degrees of angularity may be obtained by supporting the rolls for bodily shifting movement in a plane transverse to the plane of the axis of the blank and is carried out as follows: The blocks 12 and 13, which constitute convenient carriers for the two rolls, are preferably made cylindrical to conform to and turn in the bore or passage 14 in the slide. Should a blank having threads of different inclination from that represented in Fig. 5 be inserted between the lathe-centers, the rolls will automatically adjust themselves to said thread, the two blocks rotating in their seats and the threads of the rolls instantly seating themselves in the grooves of the blank. The two blocks 12 and 13 are connected with the screws 20 and 21, respectively, by couplings which permit the rotative movement of said blocks around the screws, the latter terminating at their inner ends in enlarged heads 50 and 51, fitting against plugs 52 and 53, respectively, which are seated in the outer faces of said blocks. Flanged caps, as 54 and 55, secured by screws or other suitable means to the blocks, hold the heads 50 and 51 in place. By the connections described between the feed-screws and the blocks said screws may be rotated to move the blocks in opposite directions, and the blocks may also rotate independently of the screws to adapt the rolls to threads of different inclinations.

No claims are herein made to the metal-working tool or to the method of making said tool, said method and article constituting the subject-matter claimed in my contemporaneously-pending application filed November 4, 1898, Serial No. 695,430.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a metal-working machine, the combi-

nation, with means for supporting a blank having a cut thread thereon, of means for cold-rolling said thread.

2. In a metal-working machine, the combination, with means for supporting a blank having a cut thread thereon, of means for cold-rolling said thread to precisionize the same; and means for rotating one of said parts relatively to the other.

3. In a metal-working machine, the combination, with means for supporting a blank having a cut thread thereon, of means for cold-rolling said thread to precisionize the same; and means for rotating the blank-supporting means.

4. In a metal-working machine, the combination, with means for supporting a blank having a cut thread thereon, of rolls having accurate threaded surfaces for cold-rolling said cut thread to a precisionized form of standard size and gage.

5. In a metal-working machine, the combination, with means for supporting a blank having a thread formed by cutting or removing the metal, of rolls having accurate threaded surfaces for cold-rolling said thread to a precisionized form of standard size and finish, one of said rolls being movable toward and from the blank.

6. In a metal-working machine, the combination, with live and dead centers for supporting a blank having a cut thread, of a slide; and a pair of rolls mounted upon the slide, said rolls having accurately-shaped, threaded surfaces for cold-rolling the cut threads to a precisionized form.

7. In a metal-working machine, the combination, with means for supporting a blank having a cut thread, of a pair of rolls each having accurately-formed threaded surfaces adapted to act upon said cut thread and cold-roll the same to a precisionized form, said rolls being each supported for longitudinally-yielding movement, whereby the threads on the same will automatically seat themselves in the groove between the threads of the blank.

8. In a metal-working machine, the combination, with means for sustaining a blank, of a support; a pair of threaded rolls loosely mounted in said support and adapted to act upon the blank; and springs acting against both ends of each roll, said springs permitting the rolls to yield longitudinally in either direction.

9. In a metal-working machine, the combination, with means for supporting a blank, of a threaded roll for rolling a thread previously formed on said blank, said roll being shiftably supported automatically to adapt itself to threads of various inclinations.

10. In a metal-working machine, the combination, with means for supporting a threaded blank, of a threaded roll for rolling the thread of said blank and shiftably supported automatically to adapt itself to threads of various inclinations; and a feed-screw connected to, and movable independently of, the roll.

11. In a metal-working machine, the combination, with means for sustaining a blank, of a support; a roll having a threaded surface; and a carrier for the roll loosely mounted in said support and free to move automatically therein.

12. A metal-working machine including means for cold-rolling the surface of a blank having a cut thread—said means consisting of a roll and a cooperating surface having threads of accurate form which act upon the cut threads of the blank and reduce the same by cold-rolling to a precisionized standard gage, substantially as and for the purpose specified.

13. In a machine of the class specified, the combination, with means for supporting a blank, of a threaded roll in engagement with one side of a blank; a threaded surface in engagement with the other side of said blank; a support for said roll and threaded surface, said support being movable longitudinally of the blank; a roll-carrier capable of automatic movement in the support to present the roll at the desired angle to the blank; and means for adjusting the roll toward and from the blank.

14. The combination, with a set of rolls, of a cylindrical support for each of said rolls and in which the roll is loosely mounted; and springs bearing against each side of the roll, the construction being such that the roll is permitted to have a yielding movement transversely of its support.

15. In a machine of the class specified, the combination, with the live and dead centers of a lathe adapted to sustain a blank between them, of a slide on the lathe-bed and movable longitudinally thereof; a carrier mounted for reciprocating movement transversely of said slide; rolls yieldingly mounted in said carrier to have angular adjustment therein; and springs bearing against the sides of each roll.

16. The combination, with the live and dead centers of a lathe, of a slide mounted for longitudinal movement on the lathe-bed; a carrier movable transversely with relation to said slide; cylindrical supports mounted for rotative movement in said carrier; rolls mounted on pins carried by said supports; and springs pressing against each side of the rolls whereby they are permitted to have a limited amount of movement.

17. In combination with the live and dead centers of a lathe, a set of rolls having threaded peripheries and mounted for both longitudinal and transverse adjustment between said centers; means for yieldingly supporting said rolls; a screw for adjusting one of said rolls with reference to the other roll; and a gage for indicating the amount of adjustment of the roll.

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