

Oct. 17, 1967

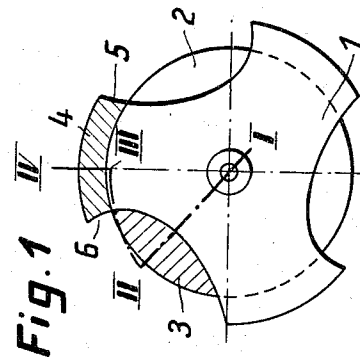
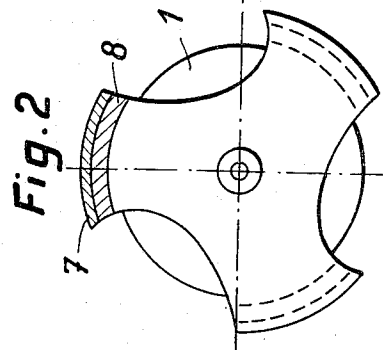
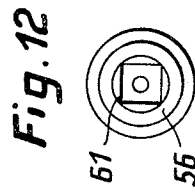
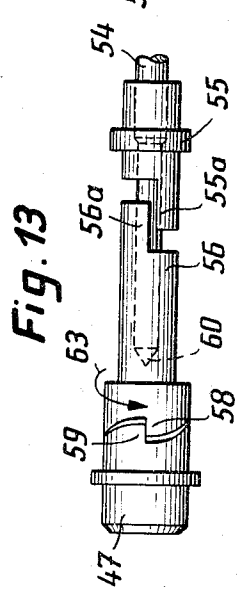
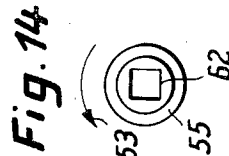
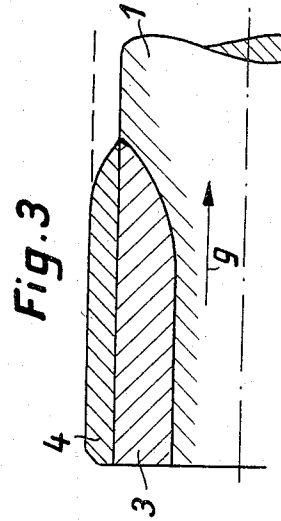
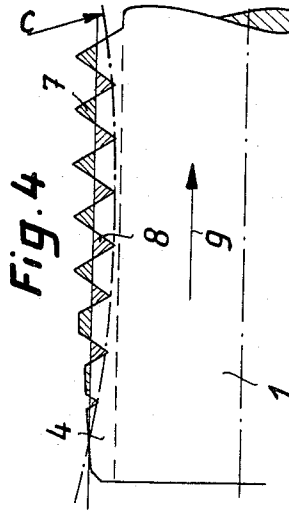
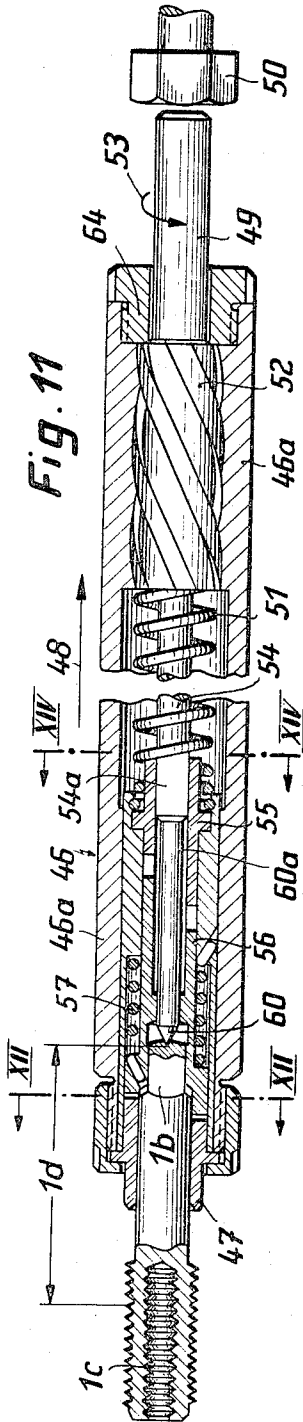
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3,347,077

PROCESS AND MACHINE TO ROLL TAP DRILLS

Filed Jan. 8, 1964

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PROCESS AND MACHINE TO ROLL TAP DRILLS

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Fig. 5

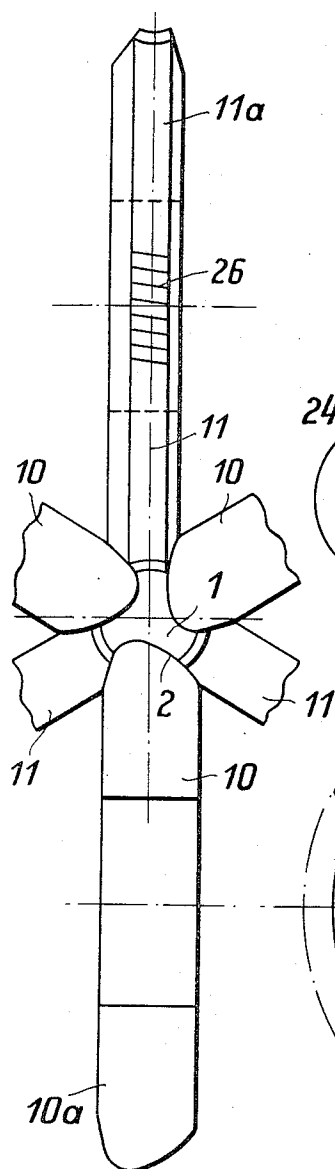
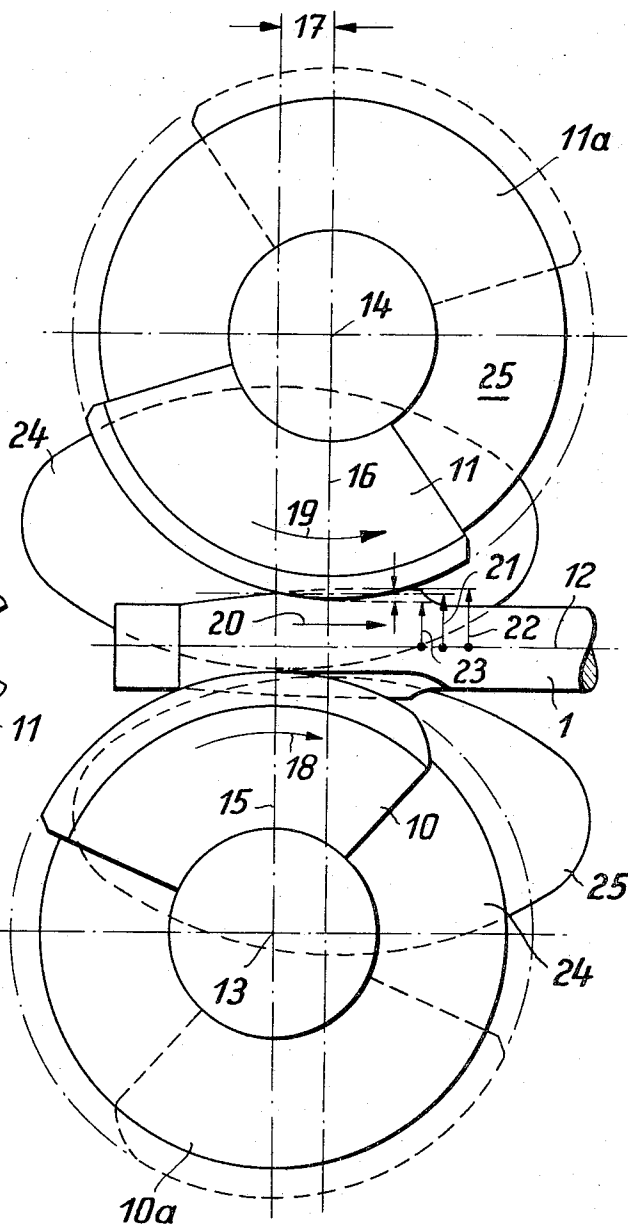


Fig. 6



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PROCESS AND MACHINE TO ROLL TAP DRILLS

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Fig. 7

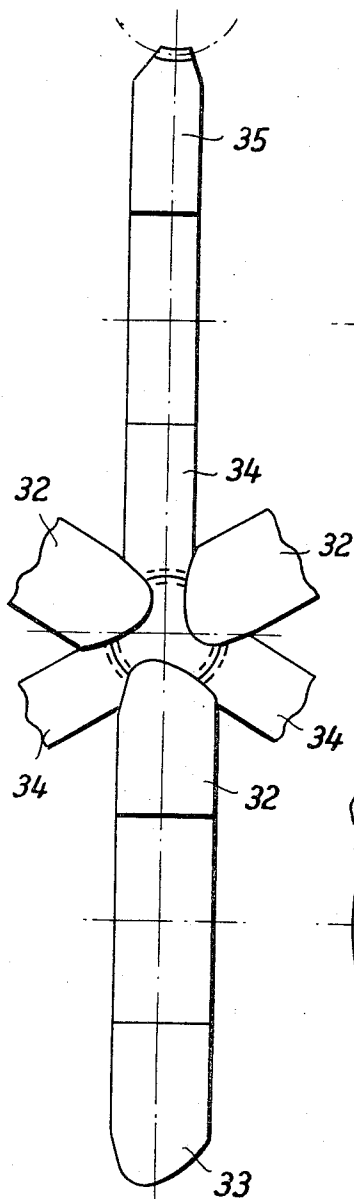
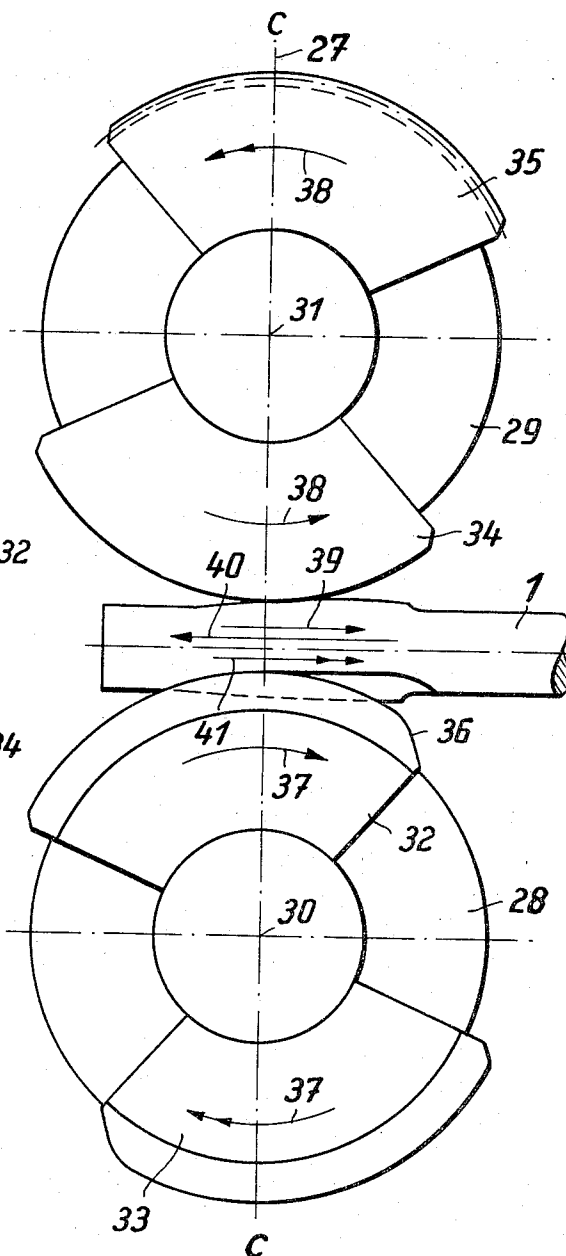


Fig. 8



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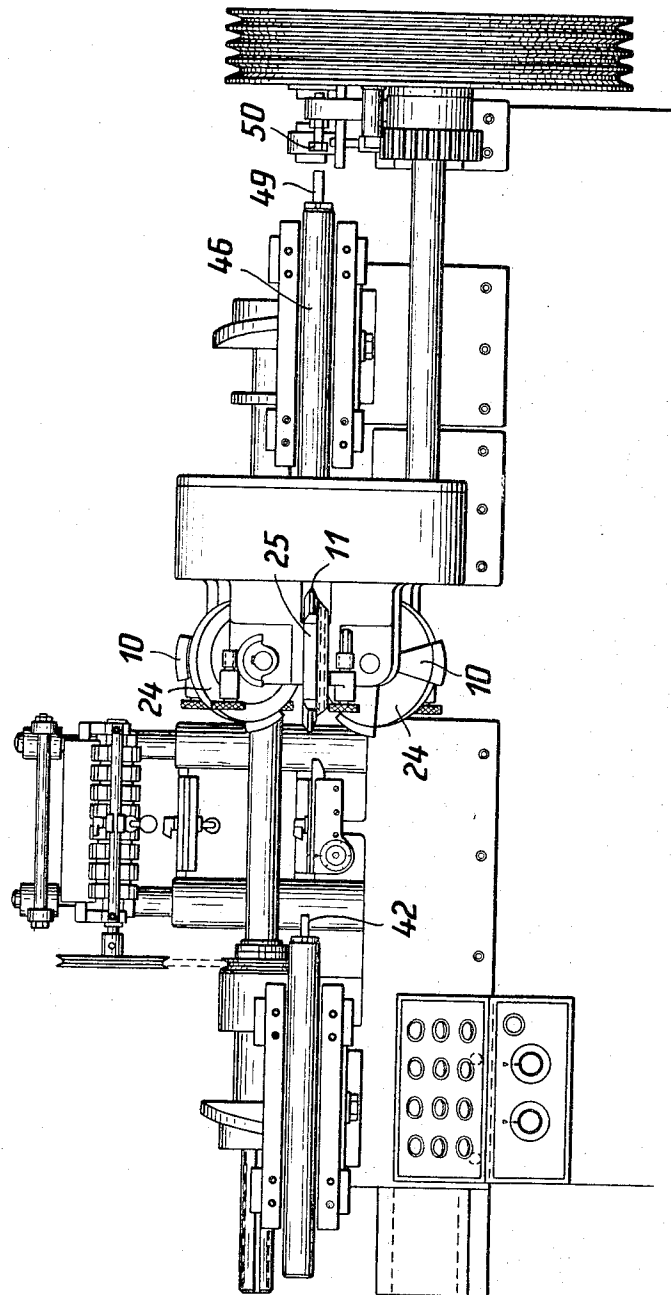
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PROCESS AND MACHINE TO ROLL TAP DRILLS

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Fig. 9



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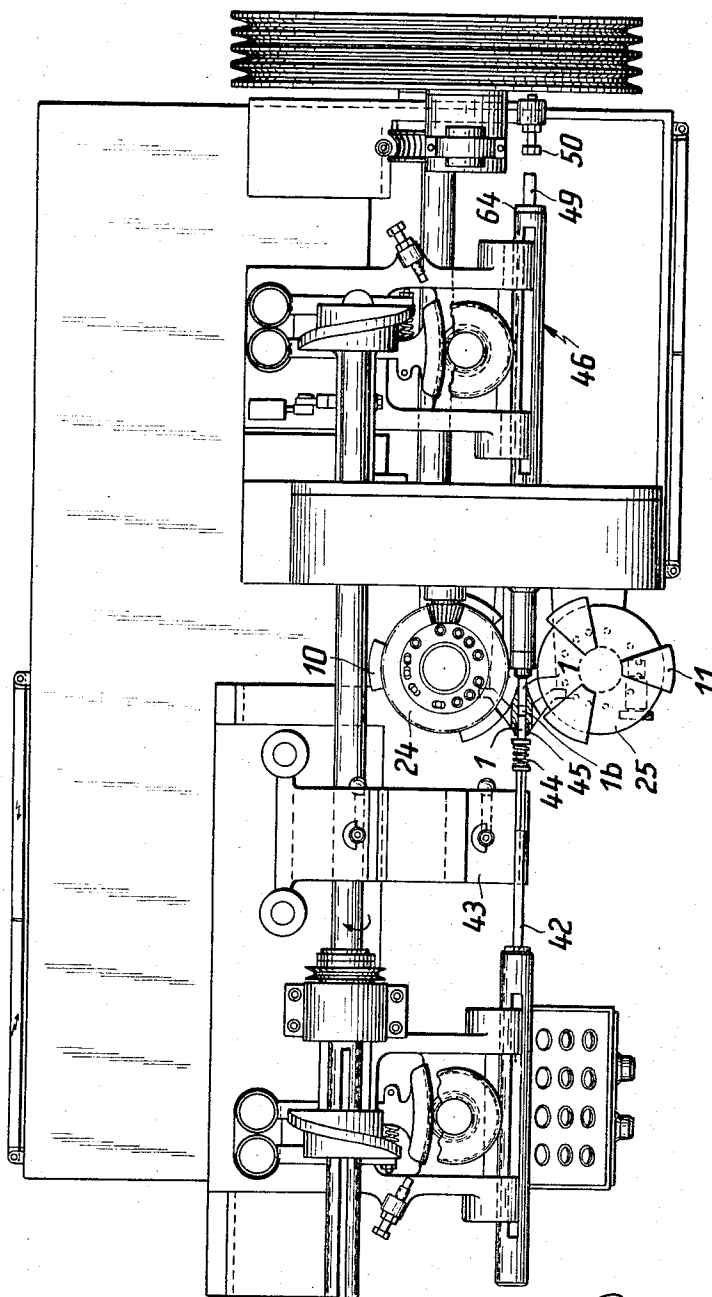
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PROCESS AND MACHINE TO ROLL TAP DRILLS

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Fig. 10



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PROCESS AND MACHINE TO ROLL TAP DRILLS

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Claims priority, application Germany, Jan 9, 1963,

E 24,141

8 Claims. (Cl. 72—202)

This invention relates to a method of rolling thread taps and to apparatus for carrying out the method according to the invention.

It is known to make thread taps by machining processes or by noncutting shaping processes, such as forging or hot and cold rolling, as well as by a combination of these two types of processes. In one such combined shaping process, either the threads are formed first by rolling them into the workpiece in a noncutting shaping process and then the chip grooves are made by milling or grinding in a machining process, or the working sequence is inverted, the chip grooves first being formed into the workpiece after being heated to a forging temperature, and the threads then being formed into the workpiece after it has been restored to a cold condition.

Attempts to roll thread taps in a single processing step have so far failed. It has been recognized that the reason for the failure of such attempts is due to the fact that when forming the chip grooves by rolling a substantial axial elongation of the workpiece results, the amount of this axial elongation is highly dependent on the various materials used, the rolling temperatures, and the rolling speeds. It is, thus, extremely difficult to control. The profile of the thread, however, must be rolled with the closest tolerances, especially with regard to the pitch of the thread, or else must be rolled with an allowance of surplus material which is removed subsequently by machining, such as by grinding. However, since until now the formation of the thread profiles by rolling and the formation of the chip grooves by rolling has always been effected in one and the same rolling plane and at one and the same time, it has been impossible to eliminate the axial displacement of the material in such a manner that when rolling the thread profiles the workpiece would theoretically form a rack meshing with the thread shaping teeth of the roll. The smallest deviations occurring in this connection result in inaccuracies of the pitch of the thread to such a degree that the finished thread taps can be made serviceable only by troublesome reworking, if the product is not to be rejected as useless right from the beginning. The shortcomings of the known processes for the production of thread taps in one operating step can be so great that the material in the region of the outer portion of the thread cutting lands separates from the remaining material of the workpiece during the thread profiling, i.e., it tears or strips off.

With the present invention, the disadvantageous effects encountered in rolling thread taps in which the rolling of the chip grooves counteracts the rolling of the threads into the cutting lands are eliminated, in that both the chip grooves and the threads are formed in the workpiece by rolling in one processing step at forging temperature with the aid of axial rolls and with sequentially timed roll passes.

The term "radial roll" means in this connection a roll which is, for instance, known in connection with the above-mentioned cold rolling process to form threads, and the axis of which extends substantially parallel to the axis of the workpiece to be rolled. If disposed exactly in parallel, such radial rolls have a pitch the direction of which is opposed to that of the pitch of the desired pro-

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file with the pitch angle of the rolling profile of the radial rolls corresponding to the pitch angle of the thread to be rolled. However, the radial rolls may also be provided with self-contained rolling profiles or rolling grooves. In such case, the radial rolls are pivoted out of their position in parallel with the axis of the workpiece to be rolled by approximately the pitch angle of the thread to be rolled.

The term "axial roll" means a roll the axis of rotation of which is essentially disposed perpendicularly to the axis of the workpiece to be rolled. The rolling profile of such axial rolls, which may be formed as axial rolls or may consist of rolling segments fastened on roll wheels, is thus disposed within the plane in which the axis of the workpiece to be rolled is also disposed. Such rolls may also be arranged so that their axes extend at an acute angle to the axis of the workpiece, but such angle must not be greater than 45° because above this angle the axial type of rolling would gradually become a radial type of rolling so that the correction of the profile of the axial roll relative to the profile to be rolled becomes too difficult. With composite profiles, as is the case, for instance, with thread taps, this correction may become impossible. If the axes of the rolls deviate from their normal position relative to the axis of the workpiece, helically extending grooves are produced by a combination of axial and radial rolling. In this operation, with a helix angle of up to 45° relative to the axis of the workpiece, the axial type of rolling is predominant. When rolling a chip groove with a helix angle of 45° , both types of rolling are equally encountered, and the profile corrections reach their maximum. At angles greater than 45° the influence of the radial type of rolling increases and, until transverse profiling by radial rolls is reached, the necessary profile correction is reduced to such an extent that, with the workpiece and the rolling axis parallel, any correction is rendered superfluous.

The rolling plane is that plane in which the axis of a roll extends with respect to the workpiece. The rolls may be disposed perpendicularly to the axis of the workpiece in a common plane but they may also be arranged in different planes or may be subdivided, respectively, as will be explained later. If angularly arranged rolls are used, it is necessary that the rolling plane is considered as a helix disposed perpendicularly to the helix angle. This helix is subdivided in accordance with the number of the rolls and the sectional segments thus cut will be arranged on the same level side by side like saw teeth.

The present invention deals with the problem of providing a process and apparatus for rolling thread taps in a single working step in which the above-mentioned disadvantages of the known arrangements and processes and the inaccuracies resulting therefrom are eliminated.

A process is already known, particularly for making rotary cutting tools, in which a round bar is heated and is immediately thereafter passed through a plurality of synchronously driven, angularly arranged rolls enveloping the workpiece so as to form a closed profile, this process being described in detail in U.S. Patent 2,901,932. The present invention starts from this known process but modifies it in such a manner that the chip grooves and the thread profiles of the cutting lands are formed in a single heating step but in a time-sequential manner. In other words, first the chip grooves are rolled and then the thread profiles of the cutting lands are formed.

According to one embodiment of the invention, the chip grooves and the thread profiles of the cutting lands are formed in one pass but in different rolling planes spaced from each other in the direction of passage of the workpiece.

This may be realized by having sets of axial rolls arranged in two planes spaced from each other by such

a distance that the axial rolls of the two sets do not interfere with each other. In this case, the axial rolls of both sets completely envelope the workpiece forming a closed profile or a roll pass through which the material of the workpiece is transmitted and is formed thereby. In this case, in the first plane, only the chip grooves are finish-rolled, while the lands are rolled only to the flank diameter.

In the second rolling plane spaced from the first rolling plane, the rolls are provided for thread profiles and, viewed in the axial direction, completely envelope the workpiece so that the material which has been displaced by the groove rolls but is still retained by them, is displaced radially from the roots of the thread into the tips of the thread, and not in the axial direction.

The groove rolls which are still in engagement at the same time also prevent the material displaced by the thread rolling from being pressed into the just finished chip grooves of the thread tap, thus preventing deformation of these chip grooves. Thus, this involves one single roll pass completely enveloping the workpiece and formed by two sets of rolls supported in two rolling planes spaced from each other, said roll pass being disposed midway between these two rolling planes.

In an embodiment which is especially preferred for larger workpiece diameters, the rolls form two roll passes separated from each other but disposed in one and the same rolling plane. The first set of rolls of this embodiment rolls the chip grooves of the threaded tap and, with the aid of smooth contour rolls, the cutting lands are pre-rolled slightly beyond the flank diameter of the thread to be rolled. Immediately upon completion of the first rolling pass, the workpiece is returned to its starting position and the rolls of the second set of rolls engage the workpiece. The groove rolls of said second set of rolls have the same profile as those of the first set, but the contour rolls of said second set of rolls are provided with a corresponding profile to roll the thread of the cutting lands. It is, thus, possible to roll the threads separately of the axial profiling of the chip grooves, thus completely eliminating the inaccuracies resulting from the axial displacement of material, and even the stripping of the threads. This constitutes an advance in the production of thread taps which has never been reached before and results especially in an improved quality of the rolled thread tap as a result of the undisturbed flow line structure of the material. In addition, as a result of the improved accuracy of the pitch of the threads, the allowance for grinding is reduced, which further contributes toward improving the production of the rolled thread taps, and at the same time substantially reduces the costs.

The rolling of thread taps with the aid of sets of rolls arranged in like planes but effective in different roll passes may be such that the workpiece is tapered in the first pass in such a manner that the thread diameter is reduced to a size less than the diameter of the shaft of the thread tap proper after the second roll pass or the thread forming, respectively. Accordingly, this embodiment of the invention may be employed also in connection with smaller thread taps with considerable economic advantage and offers the additional advantage that the two sets of rolls cooperating with each other are effective in such a manner that the first set is not only used in a preforming process but is effective also as a reducing roll pass, thus rendering a "preturning" of the workpiece to the starting diameter superfluous. The return of the workpiece to its starting position is effected by a corresponding control of a clamping and guiding device of the workpiece which need not be described in detail. After the second rolling pass has been effected, the workpiece is automatically ejected and the apparatus is then prepared for a succeeding blank which has meanwhile been heated. Thus, all the requirements for a fully automatic run-off of the sequential working steps are provided.

In order that the invention may be more readily

understood, various embodiments thereof will now be described in detail by way of example and with reference to the accompanying drawings, in which:

FIG. 1 is a view taken in an axial direction along a rounded bar which serves as the workpiece, on completion of the first rolling pass during which the chip grooves have been rolled,

FIG. 2 is a view taken in an axial direction along the same rounded bar serving as a workpiece, on completion of the second rolling pass during which the thread profile has been pressed or rolled into the cutting lands,

FIG. 3 is a partial, longitudinal view of the rounded rod shown in FIG. 1 and taken on the lines I, II, III, IV of FIG. 1,

FIG. 4 is a partial, longitudinal, sectional view of the finish-rolled thread tap of FIG. 2,

FIG. 5 is a view taken in a direction axially of the workpiece to be rolled and showing apparatus for carrying out the process comprising six axial rolls forming a closed profile,

FIG. 6 is a side view of the apparatus shown in FIG. 5,

FIG. 7 is a view taken in a direction axially of the workpiece to be rolled showing another embodiment of apparatus according to the invention,

FIG. 8 is a side view of the apparatus shown in FIG. 7,

FIG. 9 shows a partial, sectional, elevational, side view of a fully automatic machine to carry out the process in accordance with the invention,

FIG. 10 shows a partial, sectional, top plan view taken of the machine in accordance with FIG. 9,

FIG. 11 shows a longitudinal, sectional view of a detail of the machine of FIGS. 9 and 10, which is designated a synchronizing system,

FIG. 12 shows a front view of a detail of the synchronizing system in accordance with FIG. 11, taken along section XII—XII of FIG. 11,

FIG. 13 is a side, elevational view taken of a group of individual members of the synchronizing system shown in FIG. 11, and

FIG. 14 is a sectional view taken along section XIV—XIV of FIG. 11.

The mode of operation of the invention will first be explained with reference to FIGS. 1-4. Reference 1 in these figures designates the workpiece which consists of a rounded bar or rod cut to a certain length. In principle, it is possible in connection with the invention to cut these rounded bars or rods continuously from a long rod and feed them to the rolling plane or rolling planes, respectively, but the cutting of the individual rounded bars is preferably carried out previously in a separate process step.

After the rod has been heated to approximately forging temperature, chip grooves 2 are formed in the rod by rolling in a first roll pass with the aid of a set of axial rolls. This heating is carried out preferably, if not necessarily, as quickly as possible, for example, by means of a high frequency induction heater. The point is to produce the heating as quickly as possible and feed the workpiece heated to forging temperature to the rolling tools immediately thereafter so quickly that substantially no scale formation, oxidation, etc., can occur on the surface of the workpiece. The high frequency induction heater plant has proved to be especially suitable for this purpose. If other and less rapidly effective heating is employed, heating of the workpiece in a chamber filled with an inert gas is preferable.

Owing to the formation of the chip grooves 2 in the workpiece by rolling, the workpiece is on the one hand stretched, causing an axial elongation to take place. On the other hand, the material 3 is radially displaced from the axial grooves so that thread cutting lands 4 are formed. With suitable dimensioning, the diameter of the material built up for the formation of the thread cutting lands is substantially equal to the diameter of the flanks of the thread to be rolled. The accuracy of the edges 5,

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6 of the material built up to form the lands 4 is within the limits of the amount of material which has to be allowed anyway for grinding.

Immediately subsequent to the first rolling pass, the second rolling pass is carried out in accordance with FIGS. 2 and 4. During this second rolling pass the profile of the thread is formed in the material 4 of the thread cutting lands by rolling or pressing again with the aid of axial rolls. In this operation, on the one hand, the tip 7 of the thread is pressed from the material 4 and, on the other hand, the root 8 of the thread is pressed radially inward, with the diameter of the root remaining a little in excess of the original outside diameter of the rounded rod.

FIG. 4 shows how the profiling of the thread gradually takes shape during the passage of the workpiece through the rolling plane until, as is shown at the right-hand side of FIG. 4, the profiling of the thread has been finished. The left-hand side of FIG. 4 shows how at the beginning of the influence of the profile of the axial roll on the material built up into lands the formation of the profile of the thread is initiated. The synchronously driven axial rolls of the two roll passes which completely envelope the workpiece produce the transport of the workpiece 1 through the axial rolls as is indicated by the arrows 9 in FIGS. 3 and 4.

One embodiment of the invention is described with the aid of the FIGURES 5 and 6. The chip grooves 2 of the workpiece 1 which has again the form of a rounded rod, are rolled by means of three axial profile roller segments 10 which are similar to each other, while the profiling of the thread bodies is pressed or rolled with the aid of three thread profile roller segments 11 which are similar to each other. As will be seen from FIG. 5, both the three axial segments 10 together with their corresponding axial rolls 24 and the three thread rolling segments 11 together with their corresponding axial rolls 25 are displaced with respect to each other each by 120°, with the two axial rolling sets 10, 11 displaced with respect to each other by 60°. The axial segments 10 and 11 form, as is distinctly shown in FIG. 5, a closed profile when looking in the direction of the axis 12 of the workpiece to be rolled.

In accordance with FIGS. 5 and 6, a thread tap with three thread cutting lands and with non-twisted chip grooves is to be made, so that the axes of rotation 13, 14 of the axial segments 10, 11, are disposed in planes 15, 16 which are in turn disposed vertically of the axis 12 of the workpiece 1 to be rolled. As will be seen from FIG. 6, however, the plane 16 in which the axes 14 of rotation of the thread rolling segments 11 are disposed, is displaced with respect to the plane 15 in which the axes 13 of rotation of the chip groove rolling segments 10 are disposed, by a distance 17. The rolling segments 10 and rolls 24 are driven synchronously in the direction of the arrow 18 in a manner which is not shown in more detail. Correspondingly, the rolling segments 11 and rolls 25 are driven synchronously in the direction of the arrow 19. Preferably, the two sets of axial segments 10, 11 are driven by the same driving source. As will be apparent from FIG. 5, the segments 10 and 11 define a closed form or passage in the axial direction of the workpiece 1 to closely confine the workpiece.

After the workpiece 1 has been moved in any suitable manner to the three axial segments 10 in the direction of the axis 12 so that they are beginning to displace metal, further feed of the workpiece 1 in the direction of the arrow 20 is effected exclusively by the engagement of the axial segments 10 or the axial segments 11, respectively.

Therefore, as will be seen from the drawings, at first the chip groove segments 10 are in rolling engagement with the workpiece 1. In order to prevent stripping of the thread lands from the thread body, it is necessary that the thread land be rolled only after the axial profiles of the chip grooves have been completed because only from

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that moment on there is no stretching or axial elongation produced in the blank. The chip groove rolling operation and thus the axial elongation of the workpiece terminate slightly in front of the plane 15 (that means a little left of said plane 15 in FIG. 6). The engagement of the rolling segments 11 of the axial roller wheels 25 for the purpose of rolling the transverse profiling or thread profile will then take place from the plane 15 on. The beginning of the rolling engagement of the rolling segments 11 is marked by the intersection of the diameter 21 with the plane 15 in FIG. 6.

The blank is stretched only before the plane 15 by the engagement of the axial segments 10, the chip grooves being rolled at the same time and the material displaced from the chip grooves builds up the thread lands 4 slightly beyond the diameter 21 of the flanks. The stretching of the material for the purpose of rolling the chip grooves and thus the build-up of the thread lands without any transverse thread rolling terminate slightly in front of the plane 15. Now, the three profile segments 11 are engaging in this plane thus initiating the transverse thread rolling of the thread lands 4, with the previously built-up material of the thread lands being displaced from the region of the root of the thread and pressed into the peaks 7 of the thread. The rolling operation of the thread forming which started on the rolling plane 15 is terminated on the rolling plane 16, thus imparting to the workpiece a thread profile with the outside diameter 22 and the inside diameter 23.

In the example of the embodiment as described with the aid of FIGS. 5 and 6, it is diagrammatically shown that for each chip groove axial roll 24, two chip groove roll segments 10 and 10a are provided which are detachably fastened thereon. In a corresponding manner, two thread rolling segments 11 and 11a are detachably fastened on the three thread axial rolls 25. The profiling of these thread rolling segments 11 and 11a is schematically indicated at 26 in FIG. 5, with the lines 26 representing a view taken radially on a rolling segment 11, 11a from the outside.

The rolling segments 10a and 11a are then used for hot rolling another blank, the first blank 1 having been finished-rolled with the aid of the axial rolling segments 10, 11.

As has already been explained in more detail, the two sets of roll segments 10 and 11 in the projection of FIG. 5, are representing a self-contained profile. However, the two sets of roll segments 10 and 11 become effective on the workpiece in a timed sequence and constitute during the time they are effective a common closed profile transferred onto a rolling plane which is extending exactly centrally between the planes 15 and 16. An increase in the number of the rolling segments 10, 10a . . . 10n and 11, 11a . . . 11n by increasing the size of the rolling wheel 24, 25, may be carried to such an extent that for instance sets of two, three or more thread taps, i.e. precutters, intermediate cutters, and finish-cutters may be made with the aid of rolling segments mounted in a suitable sequence and in constant alternate engagement, using the same rolling wheel. This measure contributes to a reduction in costs in that, when changes are carried through, only one period of preparation is required rather than three.

When hot-rolling thread taps of larger diameters, preferably, the process in accordance with the invention and thus also the device, are modified in such a manner that the rolling is effected in one and the same rolling plane but in two rolling stages (passes) coordinated to each other which will be explained in more detail with the aid of FIG. 7.

In accordance with these figures, all the axial rolls are arranged in one and the same plane 27. On the one hand, two roll segments 32, 33 of similar design are respectively arranged on each groove rolling wheel 28. The axes of rotation of the chip groove axial rollers 28 are referenced

30 while the axes of rotation of the thread axial rolls are referenced 31. The three thread rolling wheels 29 are equipped with roll segments 34 and 35 which are provided with profilings differing from each other. The first roll segment 34 serves to build-up the thread bodies 4 and has no transverse profiling so that here an axial stretching of the material may be effected unrestrictedly. As opposed to this, the second set of roll segments 35 is provided with a transverse profiling which then carries out the thread profiling shown in FIGS. 2 and 4 on the workpiece 1 which has been retracted to the starting position in the direction 40. The three rolling wheels 28 of the groove rolls as far as they are destined to hot-roll the thread tap with three chip grooves are displaced from each other by 120°. The same applies equally to the rolling wheels 29 of the axial thread roll segments 34 and 35. Both groups of axial rolls 28, 29 are again displaced from each other by 60°.

Each chip groove rolling wheel 28 has replaceably fastened thereon, on the one hand, a chip rolling segment 32 and, on the other hand, a chip groove guiding segment 33. Each thread rolling wheel 29 has fastened thereon, on the one hand, an unprofiled thread body holding segment 34 and, on the other hand, a thread profiling segment 35. The design and mode of operation of the chip groove segments 32, 33 correspond with the design and mode of operation of the chip groove segments 10 of the embodiment in accordance with FIG. 5 and the mode of operation shown in FIGS. 1-4. Correspondingly, the design and mode of operation of the thread profiling segments 35 correspond with the design and the mode of operation of the thread rolling segments 11 of the embodiment in accordance with FIG. 5 and the mode of operation as shown in FIGS. 1-4. The chip groove guiding segment 33 is only destined to engage in a finish-rolled chip groove and assist it in retaining its proper shape.

The FIGS. 7 and 8 show the first rolling pass. Of the three chip groove rolls 28, the chip groove roll segments 32 are in rolling engagement with the workpiece 1. All the three rolls 28 are driven synchronously in the direction of the arrow 37, the synchronous drive of the rolls 29 is produced synchronously with the above drive in the direction of the arrow 38.

Simultaneously with the chip groove segments 32, the thread holding segments 34 of the three rolls 29 are in engagement with the blank 1 to be rolled. All three rolling segments 32 and all three rolling segments 34 are disposed in the rolling plane 27 and are forming a closed rolling passage enveloping the blank 1. With this embodiment, the thread lands to be formed may be within smaller ranges of diameters than the diameter of the shaft or the starting material, respectively. In this case, a pre-turning of the blank is rendered superfluous. In accordance with FIGS. 7 to 8, the thread cutting land diameter corresponding to the diameter of the flank of the thread is enveloped by the roll profile during the first roll pass.

On completion of this process step, the pre-shaped blank 1 which has been moved positively in the direction of the arrow 39 during this first roll pass by means of the axial rolls, is again moved backwards into a position which is disposed in front of the rolling plane 27. This, for instance, may be effected also by moving the blank 1 outside round the axial rolls 28, 29. This backward movement is, however, suitably effected in accordance with the arrow 40. During this backward movement of the pre-shaped blank 1, the groups of rolling wheels 28, 29 are moving on in the direction of the arrows 37, 38. The free distance between the two roll segments 32, 33 and 34, 35, respectively, makes possible a backward movement of the blank in the manner as indicated.

On completion of the backward movement, the blank is again moved towards the rolling plane 27, namely in the direction of the arrow 41. As soon as the groups of

roll segments 33-35 have begun to engage the blank, the workpiece is again positively moved onward in the direction of the arrow 41 by means of these roll segments.

Also the roll segments 33 together form a closed passage with the roll segments 35. By the influence of these roll segments on the blank, the transverse profile of the thread is pressed or rolled into the thread bodies as has been explained with the aid of FIGS. 1, 2 and 4. During this time, the profiling of the finished chip grooves is maintained by means of the chip groove retaining segments 33 of the roll 28.

When this process step has been completed, the thread tap is finished, and will be ejected.

Under certain circumstances, and with very large-sized thread taps, a multiplication of the roll passes may prove to be necessary. This is possible in accordance with the invention. However, attention will have to be paid always only to the fact that the chip groove formation which is connected with a stretching or axial elongation must be finished first, before the pressing or rolling of the transverse profiling in the thread bodies may be started. Under these circumstances, the embodiment of the invention described in connection with FIGS. 5-6 is practical only with respect to such thread taps as may be made in one single working step.

However, the embodiment described in connection with FIGS. 7-8 is suited also for especially large sized thread taps, for which a repeated rolling operation is necessary. Let us assume, for instance, that for the production of the chip grooves two passes are necessary while the transverse profiling of the threads may be pressed or rolled also here in one pass. In such a case it is only necessary to provide on the axial rolling wheels 28, 29 each three, rather than two, rolling segments respectively displaced on the axes 30 and 31. The first roll segment pre-rolls the chip grooves, the second roll segment of this axial rolling wheel finishes the chip grooves. The rolling segments of the group of rolling wheels 29 which are in engagement during this time, are only keeping the thread lands to the diameter of the flanks of the threads or a diameter, respectively, which is between the diameter of the flank and the outside diameter of the workpiece in the form of the rounded rod. The third rolling segment then serves to roll or press the transverse profile in the thread lands.

The embodiment in accordance with the FIGS. 7 and 8 is also suited for the manufacture of twisted thread taps. As a special advantage of the invention it must be mentioned that until the hardening is to be carried out, an economy of working time of roughly 90% is obtained, as compared with conventional processes. Furthermore, an economy in raw material of about 25% is resulting. Finally, a higher service life and a more favourable loading capacity may be claimed for the thread tap made in accordance with the invention.

The invention is suitably carried into practice in such a manner that a known high frequency induction heater is combined with an electronically controlled heat sensing device, a drive, and switching elements in such a way that a fully automatically controlled hot rolling plant for the manufacture of thread taps results. Such devices are described in more detail in the U.S. Patent 3,031,553 and need therefore not be explained in more detail in connection with this invention. The synchronous drive of the roll sets may be effected in accordance with the U.S. Patent 2,901,932 and need, therefore, not be described nor shown in more detail.

In the following, the fully automatic machines shown in FIGS. 9 to 14 will be described, which constitutes one of the many embodiments of a machine suitable to carry out the invention.

This machine carries on a machine frame a supply and feeding device 43 for the workpiece blanks 1; a pusher comprising a pushing ram 42; and induction coil 44 disposed behind said pusher to heat the workpiece 1, the

ancillary devices of which are not shown in more detail in addition, a rolling device in accordance with FIGS. 5 and 6 with chip groove axial rollers 24 and thread axial rollers 25 carrying the rolling segments 10 and 11, respectively; a synchronizing system 46 shown in more detail in FIGS. 11-14; and a driving and control device to apply and control the movements of the pushing ram 42, the rolls 24, 25 and the synchronizing system 46 are mounted on the machine frame. Behind the induction coil 44, a guiding bushing 45 is rigidly arranged in order to keep the workpieces in the induction coil while being heated.

The synchronizing system 46 which is shown in detail in FIGS. 11 to 14, possesses a housing 46a, with an ejector rod 49 arranged therein for longitudinal movement against the force of a coil spring 51 and rotatable via a multiple high-pitch thread. Said ejector rod 49 has a pin portion 54 with a square portion 54a terminating forwardly in a cylindrical member 60a provided with a centering peak 60.

The pin 54 supports a sleeve-like first coupling member 55 non-rotatably with respect to the square portion 54a of the pin 54 via a square hole 62 (FIG. 14) in said member 55. In a direction forwardly towards the centering peak 60 and axially of said first coupling member 55, a sleeve-like second coupling member 56 is supported which is capable of engaging between pawls 55a of the first coupling member 55 via pawls 56a (FIG. 13). In addition, the second coupling element 56 possesses coupling teeth 58 which are capable of cooperating with coupling teeth 59 of a guiding bush 47 rigidly arranged at the housing 46a of the synchronizing system 46 (FIG. 13). Furthermore, the second coupling member 56 is engaged by an end of a coil spring 57 said spring having its other end abutting at the housing 46a of the synchronizing system 46, and respectively resetting the second coupling member 56 from a rotated position.

The workpiece blanks 1 which are stored in the supply and feeding device 43 and fed therefrom, each have a square portion 1b at the end which is intended to serve later purposes of use and, with the aid of the synchronizing system is employed to bring the position of the thread bodies always into a certain relationship with respect to a surface of this gripping square 1b. For this purpose, the second coupling member 56 possesses a square hole 61 in which the square portion 1b of the workpiece blank 1 may be nonrotatably retained.

The mode of operation of the machine shown in FIGS. 9-14 as an example of embodiment, is as follows:

The workpiece blanks are disposed in the supply magazine already in such a manner that the square portions 1b are all facing in one direction, i.e. towards the rolls 24, 25 and the synchronizing system 46. A workpiece blank 1 is then introduced from the supply and feeding device 43 into the induction coil 44 by means of the pushing ram 42, and is retained therein by means of the guiding bushing 45.

After having been heated to forming temperature, the workpiece is pushed into the synchronizing system 46 by means of the next workpiece which is pushed-on by the pushing ram 42. The synchronizing system 46, at the moment during which the pushing-in is effected, is disposed in that position in which the rolling operation begins. In this position, the workpiece is introduced into the guiding bushing 47 (FIG. 11) of the synchronizing system 46.

Now, the synchronizing operation proper will run off by which the workpiece 1 is always rotated in such a manner that the square portion 1b thereof arrives at a certain position of rotation with respect to the rolls 24, 25 so that always thread profiles are obtained the thread lands 1c of which (FIG. 11) are in a certain position with respect to the square portion 1b.

During the period the previously machined workpiece is ejected which always precedes a synchronizing opera-

tion, the synchronizing system 46 is advanced in the direction of the arrow 48 so much that the ejector rod 49 abuts the solid machine abutment 50. During further movement of the synchronizing system 46, the ejector rod 49 is moving axially forwardly within the housing 46a of the system 46 against the force of the spring 51 and expels the finish-machined workpiece 1 from the guiding bushing 47. In this operation, the coil spring 51 is compressed and later will produce the backward movement of the ejector rod 49 or the relative forward movement of the housing 46a, respectively. When pushing the synchronizing system 46 on, the ejector rod 49 will be twisted via the multiple high-pitch thread 52 in the direction of the arrow 53. Along with the ejector rod 49, the first coupling member 55 is rotated via the square portion 54a and the square hole 62, and via the form-closed coupling 55a-56a shown in FIG. 13, the second coupling member 56 is also rotated, namely against the force of the coil spring 57. The twisting is carried to such a degree that the coupling teeth 58 of the second coupling member 56 are twisted with respect to the coupling teeth 59 of the guiding bushing 47 by 90°. Thus, after the ejection of the finish-machined workpiece, the second coupling member 56 which, as has already been explained, possesses a square cornered hole 61 to receive the square portion 1b of a workpiece and in addition constantly guides the cylindrical portion 60a of the ejector rod carrying the centering peak, remains displaced under the bias of the coil spring 57 at an angle of 90° in the direction of the arrow 63 with respect to its previous position and is retained in this twisted position by means of the coupling teeth 59 of the guiding bushing 47.

To receive the heated workpiece 1 to be rolled, the entire synchronizing system 46 is advanced into the rolling position against the direction of the arrow 48. During this time, the spring 51 pushes the housing 46a forwardly or the ejector rod 49 is moving backwards relative to the housing 46a until the high-pitch portion 52 of the ejector rod abuts an end stop 64 of the synchronizing system 46.

When the synchronizing system 46 has reached the rolling position, the heated workpiece will be pushed through the guiding bushing 47 into the square hole 61 of the second coupling member 56 by means of the pushing ram 42 effective through the succeeding workpiece. When the square portion 1b of the workpiece 1 is exactly in register with the square hole 61 of the coupling member 56, the workpiece 1 will advance as far as to the center peak 60 which then defines the end position. With this, the second coupling member 56 and the coil spring 57 connected thereto will be rendered ineffective. In case the square portion 1b of the workpiece is twisted relative to the square hole 61 of the second coupling member 56 it will abut against the coupling member 56 and push it backwards in the direction of the centering peak 60 so much that the coupling teeth 58 and 59 become disengaged from one another. By means of the biased coil spring 47, the second coupling member 56 will then be rotated against the direction of the arrow 63 until the square portion 1b of the workpiece comes into register with the square hole 61 and is gripped thereby. The workpiece 1 will then also be rotated. During this time, the pushing-in of the workpiece as far as to the end position defined by the centering peak is continued where the desired rolling position will be reached. Thus, with the synchronizing system 46 being employed, a very expensive sorting operation is eliminated which would otherwise have to be effected in the supply and feeding device 43.

The centering peak 60 serves, as already mentioned, as an end abutment for the workpiece 1 and thereby determines the longitudinal position of the profiling 1d of the workpiece or the thread land 1c, respectively. While being pushed-in, the workpiece is strongly struck onto the centering peak 60. Thereby, a centering impress will be formed by means of which the workpiece may then later on be exactly centered at the centering peak of a

thread grinding machine. The centering peak 60 of the synchronizing system 46 corresponds to the centering peak of a thread grinding machine. In this manner, the position of the thread profiling relative to the centering peak of the thread grinding machine or the centering cone of the thread tap, respectively, is exactly determined.

The described machine may work fully automatically and may be exactly timed, i.e. synchronized with the following working steps such as thread grinding, bevel grinding etc. By the synchronizing system 46, the following is obtained:

(1) the determination of the position of the thread lands relative to a surface of the gripping square of the thread tap and thus the determination of the position of the chip grooves;

(2) determination of the exact position of the thread profiling relative to the centering cone of the thread tap or the centering peak of a thread grinding machine, respectively.

It would also be possible in a simple manner to obtain a marking of a certain chip groove so as to exactly determine the gripping member of the thread grinding machine.

By the machine explained above and, especially, by the synchronizing system it will be obtained that all thread taps rolled in this manner are uniform to such a degree that the profiling thereof is in register with the corresponding profiling of the thread grinding wheel or the position thereof, respectively.

Consequently, the time-consuming re-adjustment of the thread grinding machine is eliminated. A special advantage of the synchronization of the working steps as explained above resides in that the oversize of the rolled thread tap allowed for grinding may be reduced to a minimum value. This again means a considerable saving in grinding wheels in addition to a substantially increased output. The reduction in the grinding oversize makes it furthermore possible that the thread profiles have a still improved quality in spite of the increased output.

What I claim is:

1. A process for forming thread cutting taps by rolling chip grooves and transverse thread teeth on thread lands located between said chip grooves on a bar blank, comprising the sequential steps of heating said blank passing said blank immediately after said heating through a plurality of synchronously driven rolls, rolling chip grooves in said blank and thereafter rolling thread teeth in said lands, said chip grooves and said teeth being formed during one heating of said blank and in one working cycle.

2. A process for forming thread cutting taps by rolling chip grooves and transverse thread teeth on thread lands located between said chip grooves on a bar blank, comprising the sequential steps of heating said blank, passing said blank immediately after said heating through a plurality of synchronously driven rolls defining a circumferentially closed passage, rolling chip grooves in said blank and thereafter rolling thread teeth in said lands, said chip grooves and said teeth being formed during one heating of said blank and in one working cycle.

3. The process for forming thread cutting taps as in claim 1, comprising rotating said blank about its axis during rolling of said chip grooves and thread teeth to form axially spiraled chip grooves and thread lands.

4. A process for forming thread cutting taps by rolling chip grooves and transverse thread teeth on thread lands located between said chip grooves on a bar blank, comprising the sequential steps of heating said blank, axially translating said blank immediately after said heating in an axial direction through a plurality of synchronously

driven rolls, rolling said chip grooves in said blank at a first axial position of said blank relative to said rolls and thereafter rolling thread teeth in said lands at a second axial position of said blank axially spaced behind said first position relative to the direction of movement of said blank, said chip grooves and teeth being formed in one heating of said blank and during movement of said blank in said axial direction.

5. A process for forming thread cutting taps by rolling chip grooves and transverse thread teeth on thread lands located between said chip grooves on a bar blank, comprising the sequential steps of heating said blank, axially translating said blank immediately after heating in a first direction into a passage defined by a plurality of chip grooves forming rolls to form chip grooves on said blank, removing said chip groove rolls from the formed chip grooves, axially translating said blank in a second direction opposite to said first direction whereby said chip grooves are removed from alignment with the axial location at which said chip grooves were formed, and axially moving said blank in said first direction into a passage defined by a plurality of thread teeth forming rolls to form teeth on said lands said chip grooves and thread teeth being formed during one heating of said blank and in one working cycle.

6. In a process for forming thread cutting taps as in claim 5, wherein the rolling of said chip grooves and said thread teeth occurs at the same axial position of said blank during movement of said blank in said first axial direction.

7. In a process for forming thread cutting taps as in claim 5, comprising the step of confining the portion of said blank defining lands during rolling of said chip grooves to preliminarily shape said lands.

8. A process for forming thread cutting taps by rolling chip grooves and thread teeth in thread lands located between said chip grooves on a bar blank wherein said blank is axially translated between a plurality of chip groove forming rollers and thread teeth forming rollers, said rollers being located at a common location with respect to the axial path of movement of said blank and having clearances defined on the peripheries thereof, said rollers continuously rotating in a blank-advancing direction, comprising the sequential steps of, heating said blank, axially translating said heated blank in a first axial direction into a passage defined by said rollers, forming chip grooves in said blank, axially translating said blank in a second direction opposite to said first direction upon the roller clearances aligning with said blank to clear said chip grooves from said common location, and again axially translating said blank in said first direction to said common location to roll thread teeth on said lands, said rolling occurring during one heating of said blank and in one working cycle.

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