This invention relates to thread rolling arrangements and concerns particularly improved thread rolling dies and methods of producing them.

Thread rolling dies in the past have comprised blocks of tool steel with grooved surfaces having serrations of the requisite contour for forming the threads to be rolled in cylindrical blanks rolled between a pair of die blocks to form screws, bolts and the like. Since the rolling must be done under pressure the die blocks must be of sufficient thickness for strength and rigidity. The die blocks must be of tool steel capable of being hardened in order that the sharpness of the grooves in the surfaces will be retained and the die will properly form the blanks. This results in relatively expensive die blocks because of the weight of the more expensive tool steel required.

It is accordingly an object of the invention to enable thread rolling dies to be made more easily and at less cost. A further object of the invention is to enable thread rolling dies to be made which have relatively thin surface strips composed of tool steel in which the thread rolling grooves are formed without the necessity for making the entire die structure of tool steel.

Other and further objects, features and advantages of the invention will become apparent as the description proceeds.

In carrying out the invention in accordance with a preferred form thereof tool steel facing strips for thread rolling dies are cold formed, e.g. by continuous drawing, extruding or rolling processes. The strips so formed are cut in the proper shapes and lengths and at the proper angles to form the facing strips of thread rolling dies and then are cemented to ordinary steel blocks, which need not be hardened steel, in order to form thread rolling dies which may be used in the same manner as conventional thread rolling dies heretofore known.

In accordance with one embodiment of the invention the tool steel strips are drawn through a die head containing a transversely movable die block with serrations formed therein which are sufficiently oblique to produce the requisite lead in the thread rolling die surface grooves. As the strip is drawn through the die head the die block moves transversely at the rate of movement represented by the lead so that the grooves in the strip and the lead therein are produced in a single operation of drawing the tool steel strip through the die head.

A better understanding of the invention will be afforded by the following detailed description considered in conjunction with the accompanying drawings in which:

FIG. 1 is a plan view of the surface of a strip of tool steel having serrations therein which extend parallel to the edge of the strip and which has been formed by drawing through a die head having a stationary die block therein.

FIG. 2 is a view of a cross section of a thread rolling die formed in accordance with an embodiment of the invention, showing a cross section of the backup block and a cross section of the facing strip cemented to the backup block as represented by the plane 2-2' indicated in FIG. 1.

FIG. 3 is a view of a longitudinal section of apparatus for rolling serrations in strips similar to those shown in FIG. 1 instead of drawing the strips.

FIG. 4 is a view of the thread rolling die represented in FIG. 2.

FIG. 5 is a side view of the thread rolling die strip of FIG. 1 illustrating the extent to which such a strip is normally bowed by the action of the groove forming teeth of the die on one side of the strip.

FIG. 6 is a view of a cross section of a die head containing a transversely movable draw die.

FIG. 7 is a view in perspective of the transversely movable draw die of the die head of FIG. 6.

FIG. 8 is a perspective view of a strip of tool steel which has been partially drawn through a die head.

FIG. 9 is a schematic diagram of a rotary type of thread rolling die illustrating the manner in which hardened steel strip facings with the requisite grooves therein may be applied to rotating drums and stationary blocks to avoid the necessity of utilizing tool steel for the entire drum and entire stationary block and reducing the cost of forming the requisite grooves in the hardened steel surfaces.

FIG. 10 is a view in cross section of a thread rolling die being employed to roll the threads in a round headed machine screw.

FIG. 11 is a schematic diagram of an extrusion press for forming thread rolling die facing strips.

FIG. 12 is a cross-sectional view of a die head with a stationary die for drawing facing strips such as shown in FIG. 1, and

FIG. 13 is a fragmentary, cross-sectional view of the apparatus of FIG. 5.

In one embodiment of the invention a thread rolling die 11 such as represented in cross section in FIG. 2 and in elevation in FIG. 4 is formed by drawing a facing strip 12 of hardenable tool steel through a suitable die and cementing the facing strip 12 to a suitable soft steel backing block 13. The strip 12 is preferably cemented to the block 13 by a suitable cement such as an epoxy resin. As the die facing 12 wears, only the facing need be changed so that there is a considerable reduction in maintenance cost. The backup block 13 provides the necessary thickness and rigidity for use in conventional thread rolling die fixtures.

The threads or serrations 14 are preferably cold formed instead of being ground or milled. A conventional tool steel which has been used heretofore for solid thread rolling dies is an air hardening steel, 5% chromium and 1% carbon. This may be melted or ground. In thread rolling dies constructed in accordance with the invention, a harder, tougher tool steel may be used such as a 4% vanadium steel. This is too hard and grindable, so that it is possible to mill it so that it cannot be used for making thread rolling dies by the conventional process. This tool steel however is more ductile and is useful for drawing die face laminae or strips such as the facing 12.

The simplest arrangement for drawing the die facings 12 is a conventional die head 15 such as used in wire drawing, see FIGURE 12, holding a die 16 similar to a wire drawing die except for having a die opening 17 which is relatively flat, oblong, shape instead of circular or square. The die opening 17 conforms to the cross-sectional shape of the die facing 12, having grooves or serrations 18 on one side and a flat surface 19 on the other side. If desired, the die 16 may be in two hardened tool steel parts, with a block 21 having the smooth surface 19 and a block 22 into which the serrations 18 are cut. Lands and a block 23 and 24 are provided in the surface having the grooves 18 and the surface 19, respectively, and the portion of the surface beyond the lands 23 and 24 is relieved as shown at 25 and 26.

When a die head 15 of the type shown in FIG. 12 is employed, the die 16 is stationary therein during the drawing process and a long strip 27 is formed on a flat, oblong cross-section blank. The resultant grooves or serrations 28 as shown in FIG. 1 are parallel to the edges of the strip 27.
However, in a finished thread rolling die a helix angle must be provided and the finished strip or die facing must have the grooves 14 running diagonally or obliquely with respect to the rolls. In order to form such die facings from a strip such as the strip 27 of FIG. 1 the strip 27 is cut into separate pieces 29 along saw cuts 31 and 32 which are at an angle to the edge of the strip 27. Each piece 29 cut from the strip 27 thus forms a separate die facing such as the die facing 12 of FIGS. 2.

One of the advantages of forming strips with straight serrations is that a blank is provided that can be made into a variety of dies. For example to roll the sixteen common sizes of screws one would need only nine pitches of thread. To break it down further to roll thirteen of the most popular sizes of thread one would need only six pitches of threads. The time required to form the thread is minute in comparison to either grinding or milling.

Preferably however a die head is employed of such construction as to enable the helix angle to be formed into the die facing strips as the strips are drawn through the die. A suitable die head 33 for this purpose is illustrated in FIG. 3, and the die head 33 comprises the casing or block 34 with a draw opening 35 for a blank 36 being drawn and having a transverse channel 37 slidably receiving a transversely movable draw die 38.

Although the die head casing 34 may, if desired, be a solid block except for the transversely slidable draw die 38, preferably it is fabricated from separate pieces for convenience in manufacture and in order to permit replacement of surfaces subjected to the greatest wear. Accordingly as shown, the die head casing 34 comprises two blocks 39 and 40 joined by two spacer blocks 41 and 42 having central openings 43 and 44 therein to provide passage space for the blank 36. If desired, replaceable wear plates 45 and 46 may be provided.

The draw die 38 as shown has a grooved or serrated surface 47 with the entry portion 48 beveled, the grooves in the bevel 48 forming continuations of those in the main portion of the grooved surface 47. Preferably a separate backup block 49 is provided which also has a beveled entry surface 51 opposite the bevel 48 of the draw die 38. The backup block 49 preferably also has a relieved portion 52 so that the principal loading upon the blank 36 takes place at the portion 53 of the draw die 38 just beyond the edge of the bevel 48.

Each of the grooves 54 extends slightly diagonally so that when the blanks 36 are drawn past the die, slightly diagonal grooves are formed in the blank 36, which will provide the requisite helical lead on the finished thread rolling die. The surface shape of the draw die 38 is such that loading and tensile stress upon the blank 36 is distributed along the smooth surface of the projecting portion of the backup block 49 in contact with the back surface of the blank 36. In this manner relatively tough tool steel may be employed for the blank 36 without exceeding its tensile strength in the drawing of the blank.

Since greater stress is applied to the grooved surface 56 of the blank 36 than to the smooth back surface 57, the drawing process will cause the blank 36 to become slightly bowed lengthwise thereby facilitating pieces thereof being applied to a block which has beveled ends. The blanks 36 are drawn in relatively great lengths and then cut up to form the die facings 12 shown in FIG. 4. The backing block 13 as shown in FIG. 4 has end portions 58 and 59 of the surface slanting slightly downwardly.

When the die facing 12 is applied to the backing block 13 the center portion is flattened and the end portions are fitted down against the beveled surfaces 58 and 59 of the block 13 before gluing. It will be understood that in conventional thread rolling dies the ends are beveled by special machining steps. This is necessary in order that a screw blank into which a thread is to be rolled can be accepted properly between two confronting thread rolling dies to start the process of rolling the thread into the screw blank. The tapered ends provided in a flat die serve to ease the screw to be rolled into and out of the die. The use of glued bowed die facings eliminates the extra operation of cutting this angle or special machining which would be necessary in a case of a solid die.

Among the advantages of the cold formed die construction is that the grain is substantially continuous with the serrated surface, being bent into continuous waves so as to provide a strong tooth construction. In the conventional dies formed by milling or grinding of teeth, the grain structure is interrupted since it runs transverse to the teeth and teeth are easily broken off. This is the cause of frequent die breakages particularly at the areas near the ends of the screws being rolled.

Referring to FIG. 10 it will be observed that when a round headed screw 61 is being formed from a blank by rolling between a pair of thread rolling dies 62 and 63, there is no lateral stress on the die tooth 64 in the intermediate portion of the screw 61 since both sides of the tooth are loaded. However a cantilever beam force is applied to the tooth 65 at the end of screw 61 as by rolling pressure on the left hand side but not on the right hand side thereby producing a strong bending stress along the grains which have been severed in the case of a machined or ground die. In the case of the cold formed die, formed by the process of drawing, however the force is across the grain so that the bending and shearing forces and the tendency for die breakage from this cause is overcome. As an example of the saving in cost of tool steel, a No. 10 die may be considered. In this case the conventional die size is \(1.25\) inches in thickness. By using a die facing of \(\frac{1}{4}\) inch thickness with the threads formed on it glued to a soft steel or other less expensive backing block, when tool steel there is a reduction of nearly three-fourths the weight of tool steel required. As the die wears out from use, only the facing need be replaced, thereby effecting a further considerable reduction in cost. With a facing \(\frac{1}{4}\) inch thick the facing thickness may be of the order of ten times the depth of groove. However it will be understood that if desired even thinner facing strips may be employed.

The long-strip, laminar die facings produced by cold forming such as by drawing through a die as described in connection with FIGS. 6, or 12 are advantageous also in formation of continuous roll dies such as illustrated in FIG. 9. Such dies included a coiling drum or roller 66 and a stationary die block 67. In order to avoid the material cost of a complete drum 66 composed of tool steel of suitable hardness and toughness and to avoid the machining cost of grooving the surface of such a roll, in accordance with the invention, a soft steel drum 68 may be employed with a continuous, annular, laminar die facing 69 bent around the periphery of the drum 68 and applied thereto by gluing as in the flat die 11 of FIG. 4.

It will be understood that a strip such as the strip 27 is employed of the proper length or the strip is cut to the proper length and the ends are faced as shown in FIG. 2. There being to form a shell embracing the periphery of the drum 68. The stationary die block 67 may also advantageously be composed of a soft steel backup block 73 with a die facing 74 glued thereto. The die facing 74 is a length of the strip 27 which has been produced by cold forming and is glued to the block 73 by bending it to the appropriate shape.

A continuous roll die such as illustrated in FIG. 9 operates by the rotation of the drum 65 in the direction of the arrow 75 with screw blanks 76 being dropped in the direction of the arrow 77 and being rolled by pressure acting between the laminar die facing 69 and the laminar die facing 74 until they emerge at the end 78 as finished screws with threads rolled thereon. At the entry end adjacent the arrow 77 the spacing between the die facings 69 and 74 is greater than subsequent to the entry end in order to facilitate the acceptance of the blanks 76 and
the bite of the thread forming serrations on the die faces into the screw blanks.

The distribution of the loading along the length of the blank in a die may be made less critical and lower tensile strength tool steel may be employed for producing the die facings, if desired, by extruding the die facing blanks instead of drawing them. For example as illustrated in FIG. 11 an extrusion press 79 is employed as schematically indicated, including an extrusion die 81, and a ram 82 for driving a blank 83 past the groove forming teeth 84 of the die. The pattern in the die facing is well formed because the material is fully flowed against the grooves in the die. There is no danger of rupturing the blank 83 in case a low tensile strength material is used therefore.

Although draw dies and extrusion dies have been described and illustrated for formation of die facings for cold-formed, thread-rolling dies, it will be understood that the invention is not limited thereto and does not exclude other methods of cold forming dies or die facings. For example if desired, the die facing itself may be rolled formed by apparatus such as schematically illustrated in FIGS. 3 and 13 of the drawings.

In this case a blank 85 is placed in a bed plate 86 having a channel 87 (FIG. 13) fitting the edges of the blank 85 so as to prevent the blank from being spread by the action of the groove forming roller 88 which is pulled along an upper surface of the blank 85 under pressure by means of a strip 89 engaging the top of the die roller 88. It will be understood that the die roller 88 has the groove formed in the surface therein of the requisite helix angle so that the blank 85 is grooved with the desired helix angle in a single operation.

In order to apply suitable pressure to the roller 88, means are provided, represented schematically as taking the form of a series of screw jacks 91 bearing downward on a top-plate 90 carrying friction-reducing rollers 92 under which the strip 89 passes as it is pulled in the direction of the arrow 93 to cause the die roller 88 to roll along and cut into the surface of the blank 85. In order to avoid the necessity for a bed plate and pressure applying assembly as long as the blank 85, the operation may be performed intermittently by rolling the thread making grooves into successive lengths of the blank 85.

This may be accomplished by intermittently releasing the pressure by backing off the screw jacks 91 and advancing the blank 85 a distance somewhat less than the length of the bed plate 86 and then again tightening down the screw jacks 91 and continuously tightening the jacks 91 with successive drafts back and forth of the pull strip 89 until the thread has been fully formed in the surface of the blank 85 being worked upon. The thread forming grooves go more deeply into the forward end of each successive length of the blank 85 than the other end of such a length. When the screw jacks 91 are backed off so that the blank 85 can be advanced, a successive portion of the contour is formed in the blank 85, deepening the grooves on the portion which was previously lightly grooved and starting the groove in the portion which was previously smooth.

Certain embodiments of the invention and certain methods of operation embraced therein have been shown and particularly described for the purpose of explaining the principle of operation of the invention and showing its application, but it will be obvious to those skilled in the art that many modifications and variations are possible, and it is intended therefore, to cover all such modifications and variations as fall within the scope of the invention.

I claim:
1. The method of producing thread rolling dies which comprises the steps of rolling a grooved, hardened roller along the surface of a die metal blank, applying pressure to the roller as it is being rolled, cutting the strip into pieces, cementing each piece onto a backing block, and intermittently relieving the pressure of the roller on the blank as the blank is advanced with successive portions of the blank being grooved.

2. The method of forming thread rolling dies which comprises the steps of drawing a strip of die metal through a die block having one side with serrations thereon conforming to the contour of desired threads to be rolled, providing relative transverse movement between the drawn strip and the die block as the strip is being drawn to form the requisite lead in the grooves of the thread rolling die strip, and cutting the drawn strip into lengths corresponding to the desired length of a thread rolling die.

3. The method of forming thread rolling dies which comprises the steps of drawing a strip of die metal through a die block having one side with serrations thereon conforming to the contour of desired threads to be rolled and by drawing the die metal strip substantially parallel to the length thereof, and subsequently cutting the die metal strip into pieces having edges oblique to the edges of the die metal strip which was drawn in order to produce the requisite lead on thread rolling dies formed from the cut strips.

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