The stationary die of the machine is supported on a stack of four relatively adjustable members which may be quickly and easily adjusted to position the stationary die with respect to the movable die and establish the proper alignment, transverse spacing, squeeze and taper angles between the dies.

6 Claims, 6 Drawing Figures
This invention relates to a thread rolling machine of the type in which a movable die is reciprocated back and forth relative to a stationary die in order to form threads on the shanks of fastener blanks which are fed successively between the dies. Such a machine is capable of forming threads on many different types and sizes of blanks and thus is often changed over at frequent intervals to accommodate different blanks. Such a changeover not only may involve changing the dies but also may require several set up adjustments in order to place the thread forming elements of the dies in proper longitudinal alinement and to establish the proper transverse spacing, squeeze angle and taper angle between the dies.

SUMMARY OF THE INVENTION

The general aim of the present invention is to provide a new and improved thread rolling machine of the above character in which the various set up adjustments may be made more quickly, more precisely and with less trial and error than has been possible with prior machines.

A correlated object is to provide a thread rolling machine which may be easily set up by a comparatively unskilled operator who may make fine adjustments while running the machine at high speed so that the operating characteristics of the machine may be taken into account in making final adjustments to the machine.

A more detailed object is to achieve the foregoing by providing a machine in which all of the die set up adjustments are made to the stationary die, the latter being carried on a series of stacked members which are adjustable relative to each other and which may be easily moved to effect adjustment of the stationary die to various positions.

The invention also resides in the unique mounting and arrangement of the die carrying members and in the novel manner in which the members are adjusted.

These and other objects and advantages of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary side elevationary view of a new and improved thread rolling machine incorporating the unique features of the present invention.

FIG. 2 is a view of the machine taken along the line 2—2 of FIG. 1.

FIG. 3 is a cross-section taken substantially along the line 3—3 of FIG. 1.

FIGS. 4 and 5 are enlarged fragmentary cross-sections taken substantially along the lines 4—4 and 5—5, respectively, of FIG. 2.

FIG. 6 is an exploded perspective view of parts of the machine.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawings for purposes of illustration, the invention is embodied in a flat die thread rolling machine 10 for forming threads on the shanks of generally cylindrical blanks 11 which ultimately become threaded fasteners. The blanks are fed one at a time between a stationary die 13 and a movable die 14 and the threads are formed as the movable die reciprocates past the stationary die to roll the blank along and between the opposing faces of the dies.

More specifically, the machine 10 comprises a box-like support or frame 15 upon which is mounted a flat base plate 16, the base plate being inclined downwardly and forwardly at an angle of about 30°. The stationary die 13 is mounted in a fixed position on the base plate while the movable die 14 is supported for back and forth reciprocation relative to the stationary die by a guide shoe 17 which is mounted on the base plate and which receives a sliding die holder 19 within which the movable die is clamped. To reciprocate the movable die, a connecting rod 20 (FIGS. 2 and 3) is pivotally secured at one end to the die holder and at its other end to an eccentric 21 which projects axially from a flywheel 23. The latter is keyed to one end of a shaft 24 which is power-rotated by a belt 25 (FIG. 1) extending between the other end of the shaft and the drive shaft of a rotary power source (not shown). When the movable die 14 is at one extreme end of its stroke, its leading edge is located adjacent the leading edge of the fixed die 13 and in a position where a fastener blank 11 may be fed between the dies (see FIG. 2). Thereafter, the movable die is shifted to the right and causes the blank to roll between the dies to form the threads. As the movable die reaches the other extreme end of its stroke, the newly threaded fastener falls out of the dies and into a collecting hopper. The machine 10 operates at high speeds and is capable of threading more than 1,000 blanks per minute.

To deliver the blanks 11 into the dies 13 and 14, a parallel set of rails, adjustable in width to accommodate the blank shank diameter, form a slotted track 26 (FIG. 2) which extends rearwardly from the dies to a vibratory bowl (not shown). Blanks fed from the bowl gravitate down the track to a point adjacent the dies and are stopped by a spring-loaded gate 27 which extends across the track. Each time the movable die 14 is retracted, a feed finger 28 engages the leadingblank and pushes the latter past the escapement gate 27 and into the gap between the dies. The feed finger 28 is carried on one end of a slide 29 which is mounted for reciprocation in a guideway 30 on the base plate 16. A roller 31 is journaled on the other end of the slide and is engageable with an inclined cam surface 33 formed on a block 34 which is supported by the guideway 30 to reciprocate at right angles to the slide. Reciprocation of the block is effected by a link 35 connected to a pivoted bellcrank 36 which, in turn, is connected by a link 37 to an eccentric 39 located on the end of the shaft 24 opposite the flywheel 23. When the block 34 is advanced to the position shown in phantom in FIG. 2, the cam surface 33 retracts the slide 29 and the feed finger 28 preparatory to the latter engaging the next blank 11. When the block 34 is retracted, the feed finger is advanced through its forward feeding stroke by a coil spring 40 telescoped into a bore 41 in the rear end of the slide and compressed between the bottom of the bore and the rear end of the guideway 30.

As shown in FIG. 2, the feed finger 28 is disposed at an angle of about 45 degrees with respect to the dies 13 and 14. The particular angular disposition of the feed finger facilitates movement of the blank out of the track 26 and around the forward leading corner of the fixed die 13. As a result, each blank 11 stripped from
the track 26 is positively forced through the spring-loaded gate 27 and against the movable die 14 by the pressure applied by the feed finger 28 and such pressure also assists in initiating rotation of the blank between the dies.

The dies 13 and 14 are generally block-shaped and their opposing faces are formed with longitudinally extending thread forming elements 43 (FIGS. 3 and 6) in the form of alternating flutes and valleys which extend along the faces in accordance with the helix angle of the thread to be formed. In order to properly form the thread, it is necessary that the dies be positioned longitudinally (i.e., in the direction of reciprocation) with respect to one another such that the thread forming elements of one die align correctly with those of the other die in such a manner that the impressions made by each die will form a continuous thread on the blank 11 rather than two interrupted threads. Also, the proper squeeze angle \( \alpha \) (FIG. 2) must be established between the dies in accordance with the diameter of the particular blank and the depth of the particular thread. That is to say, the face of the stationary die 13 must converge toward the face of the movable die 14 at a precise squeeze angle as the screw proceeds along the dies so that the dies may make the thread progressively deeper. The two dies must be transversely spaced from one another in accordance with the diameter of the blank and, in addition, the face of the stationary die 13 must be tilted upwardly and rearwardly at a proper tilt angle \( \delta \) (FIG. 4) with respect to the face of the movable die if the blank is formed with a downward taper.

Accordingly, it is necessary that the dies 13 and 14 be properly set up relative to one another in accordance with the thread to be formed. By employing different dies, the machine 10 may be used to form different types of threads on different types and sizes of blanks. When the machine is changed over from one run to another, the relative position of the dies must be adjusted to establish the proper longitudinal alignment and transverse spacing of the thread forming elements 43 and to place the die faces at the proper squeeze and tilt angles \( \alpha \) and \( \delta \).

In accordance with the present invention, set up and adjustment of the machine 10 are significantly simplified by making all of the adjustments to the fixed die 13 and by mounting such die on a uniquely arranged stack of members 44, 45, 46 and 47 which are movable relative to one another and which may be easily adjusted to establish the proper positioning of the fixed die. With the present machine, even a comparatively unskilled operator can quickly make the proper set up adjustments without going through the usual long and tedious trial and error procedure. Moreover, the longitudinal alignment and the squeeze angle \( \alpha \) of the dies may be finely adjusted after the machine is cycling at high speed and thus the operator may correct for any variations which may be brought about by the dynamic characteristics of the machine.

More particularly, the bottom member 44 of the stack comprises a flat mounting plate adapted to be adjusted back and forth along a linear path which parallels the path of reciprocation of the movable die 14, such adjustment effecting a change in the longitudinal alignment of the dies 13 and 14. The mounting plate 44 is supported directly on top of the base plate 16 and is releasably secured to the latter by two screws 49 (FIG. 6) which extend through elongated slots 50 in the mounting plate and which are threaded into holes 51 in the base plate. The underside of the mounting plate 44 is formed with an elongated rectangular pocket 53 (FIG. 4) which receives the upper portion of a similarly shaped key 54. The key is anchored to the mounting plate 16 by screws 55 and its lower portion is slidable received in an elongated slot 56 formed in the base plate 16 (see FIGS. 5 and 6).

Adjustment of the mounting plate 44 is effected by turning a tubular screw 57 (FIG. 5) which is threaded through the base plate 16 with its inner end in engagement with the end of the key 54. A second screw 59 extends through the screw 57 and is threaded into a bore 60 in the key 54. When the screw 59 is loosened, the mounting plate 44 may be adjusted back and forth simply by turning the screw 57. Such adjustment changes the longitudinal position of the stationary die 13 with respect to the movable die 14 and thus may be used to bring the thread forming elements 43 into proper alignment. Accordingly, the mounting plate 44 and the screw 57 enable the operator to quickly and easily set up the machine 10 to bring the dies into alignment. Advantageously, the initial alignment set up may be adjusted in fine increments while the machine is operating at high speeds. As a result, the operator may make a corrective adjustment if that should be necessary to take into account the effect of the inertia of the movable die or other dynamic factors.

The second member 45 in the stack comprises a swing plate (see FIG. 6) which may be adjusted to change the squeeze angle \( \alpha \) of the dies 13 and 14. The swing plate is mounted to pivot about an axis extending perpendicular to the path of reciprocation of the movable die 14 and may be adjusted about such pivot to change the squeeze angle. For these purposes, an up-right pivot element or pin 61 extends through a hole 63 in the swing plate 45 and is press-fitted into a hole 64 in the mounting plate 44, the upper end of the pin being just below the upper surface of the swing plate. Importantly, the axis of the pivot pin coincides quite closely with the effective leading edges of the thread forming elements 43 of the stationary die 13 (see FIG. 2), such edges being defined in this instance by the forward leading corner of the die. As a result, adjustment of the swing plate 45 about the pivot pin 61 is effective to change the squeeze angle \( \alpha \) but does not substantially change the transverse spacing between the forward leading corner of the stationary die and the opposing face of the movable die 14. Whenever the mounting plate 44 is adjusted linearly, the swing plate 45 also is adjusted in the same direction and thus the squeeze angle \( \alpha \) is not affected by adjustment of the mounting plate.

Pivotal adjustment of the swing plate 45 is achieved by adjusting two screws 65 (FIGS. 2 and 6) which are located adjacent diametrically opposite flats on the upper end portion of a stationary pin 66. The latter is press-fitted into a hole 67 in the mounting plate 44 and its upper end portion projects into an enlarged hole 69 formed on the swing plate 45. The adjusting screws 65 are threaded through the swing plate 45 and project into the hole 69 in engagement with the flats so as to enable angular adjustment of the swing plate by loosening one screw and tightening the other. Such adjustment may be made while the machine 10 is running and thus the operator may easily make a corrective adjustment to the squeeze angle \( \alpha \) under dynamic conditions.

To enable adjustment of the transverse spacing between the dies 13 and 14, the third member 46 (FIG. 6)
in the stack comprises a slide plate which is mounted on top of the swing plate 45 and which is supported for back and forth linear adjustment along a path extending substantially perpendicular to the path of reciprocation of the movable die 14. Housing for the slide plate 46 is fastened adjustably to the swing plate 45 by screws 70 extending through elongated slots 71 in the slide plate and holes 73 in the swing plate and threaded into holes 74 in the mounting plate 44. An elongated key 75 of rectangular cross-section is fastened within a similarly shaped slot 76 on the underside of the slide plate 46 and is slidable received in a slot 77 in the upper side of the swing plate 45 to guide the slide plate for back and forth movement.

Such movement is produced by turning a screw 79 (FIG. 6) at the rear of the slide plate 46. The screw is tubular and is threaded into a block 80 at the rear of the slide plate 46, the block being received within a pocket in the swing plate 45 and being bolted to the swing plate. A second screw 81 is telescoped into the screw 79 and is threaded into a bore 83 (FIG. 4) in the slide plate 46. The forward end of the screw 79 abuts the rear end of the slide plate and thus, when the screw 81 is loose, tightening and loosening of the screw 79 serves to adjust the slide plate forwardly and rearwardly, respectively. Accordingly, the transverse spacing of the dies 13 and 14 may be adjusted simply by loosening the screw 81 and changing the setting of the screw 79 and such adjustment does not affect the longitudinal alignment or the squeeze angle a of the dies.

In keeping with the invention, the feed track 26 and the feed finger 28 are adjusted automatically whenever the slide plate 46 is adjusted either directly by adjustment of the screw 79 or indirectly by adjustment of the mounting plate 44 or the swing plate 45. For this purpose, the guideway 30 for the slide 29 of the feed finger 28 is attached to the slide plate 46 by screws (not shown) which are threaded into tapped holes 84 (FIG. 6) formed in a tongue 85 on the slide plate. In addition, the track 26 is secured to brackets 86 which are attached to an elongated block 87 received in a slot 89 in the slide plate 46 and fastened to the latter by screws 90, the block directly underlying the track. Accordingly, the guide track 26 and the feed finger 28 are adjusted in unison with the slide plate 46 so as to maintain the same relationship between the track, the finger and the stationary die 13 whenever any one of the plates 44, 45 or 46 is adjusted.

In order to enable adjustment of the taper angle b of the stationary die 13, the latter is carried on the fourth member 47 which comprises a die holder adapted to be pivoted about an axis extending substantially parallel to the path of reciprocation of the movable die 14. The die holder 47 rests on top of the slide plate 46 and is accurately located between the block 87 and a shorter block 91 (FIG. 6) received in a slot 93 in the upper side of the slide plate and fastened to the slide plate by screws 94.

As shown in FIGS. 4 and 6, a pivot pin 95 extends through a hole 96 (FIG. 6) in the lower forward portion of the die holder 47 and is rigidly secured at its ends within holes 97 in the forward end portions of the guide blocks 87 and 91. By swinging the die holder 47 upwardly and downwardly about the pin 95, the taper angle b of the stationary die 13 may be changed. Such swinging is effected by turning a tubular screw 99 (FIGS. 4 and 6) which is threaded into the die holder 47 with its lower end bearing against the slide plate 46, there being a second screw 100 extending through the screw 99 with radial clearance and threaded into a hole 101 (FIG. 6) in the slide plate. After the die holder 47 has been adjusted to establish the proper taper angle b, it may be clamped in position by the locking screw 103 (FIG. 4) extending downwardly through the die holder 47 with radial clearance and threaded into a hole 104 (FIG. 6) in the slide plate 46.

From the foregoing, it will be apparent that the present invention brings to the art a new and improved flat die thread rolling machine 10 in which the fixed die 13 is uniquely supported on a stack of four members 44, 45, 46 and 47 which are adjustable relative to one another to enable easy changing of the position of the fixed die for the purpose of establishing the proper longitudinal alignment, transverse spacing, squeeze angle a and taper angle b between the fixed die and the movable die 14, It should be appreciated that calibrated scales may be associated with the various members to enable adjustment of the members to precisely predetermined positions and thus facilitate setting up of the machine.

I claim:

1. A flat die thread rolling machine comprising a support; stationary and movable dies on said support and having opposed faces with thread forming elements extending therealong; means for reciprocating said movable die back and forth relative to said stationary die between first and second positions and along a first path extending in the same general direction as said thread forming elements; mechanism for feeding a fastener blank between said dies each time said movable die is in said first position; and means mounting said stationary die on said support for selective adjustment relative to said movable die, said mounting means comprising a first member mounted on said support for back and forth linear adjustment along a path extending substantially parallel to said first path thereby to enable adjustment of the longitudinal alignment of the thread forming elements of said dies, a second member mounted on said first member for back and forth angular adjustment relative to said first member about an axis extending substantially perpendicular to said first path thereby to enable adjustment of the squeeze angle between the thread forming elements of said dies, a third member mounted on said second member for back and forth linear adjustment relative to said second member along a path extending substantially perpendicular to said first path thereby to enable adjustment of the thread forming elements of said dies, and a fourth member carrying said stationary die and mounted on said third member for back and forth angular adjustment relative to said third member about an axis extending substantially parallel to said first path thereby to enable adjustment of the taper angle between the thread forming elements of said dies; and said feeding mechanism being mounted on said third member and being adjusted with said stationary die whenever said first, second or third members are adjusted.

2. A flat die thread rolling machine comprising a support; stationary and movable dies on said support and having opposed faces with thread forming elements extending therealong; means for reciprocating said movable die back and forth relative to said stationary die between first and second positions and along a first path extending in the same general direction as said thread forming elements; mechanism for feeding a fas-
tener blank between said dies each time said movable die is in said first position; and means mounting said stationary die on said support for selective adjustment relative to said movable die, said mounting means comprising first and second members mounted for back and forth linear adjustment along paths extending substantially parallel and perpendicular, respectively, to said first path thereby to enable adjustment of the longitudinal alignment and transverse spacing, respectively, between the thread forming elements of said dies, third and fourth members mounted for back and forth angular adjustment about axes extending substantially perpendicular and parallel, respectively, to said first path thereby to enable adjustment of the squeeze angle and taper angle, respectively, between the thread forming elements of said dies; and one of said members carrying said stationary die and being supported on the other three members so as to be adjusted whenever any of the other three members is adjusted and to undertake the same movement as the other adjusted member.

3. A thread rolling machine as defined in claim 2 in which said feeding mechanism is carried on one of said members and is adjusted whenever such member or two of the other members are adjusted.

4. A thread rolling machine as defined in claim 2 further including a pivot element mounting said third member for swinging about said perpendicular axis, such axis coinciding substantially with the effective leading edges of the thread forming elements of said stationary die.

5. A flat die thread rolling machine comprising a support; stationary and movable dies on said support and having opposed faces with thread forming elements extending therealong, means for reciprocating said movable die back and forth relative to said stationary die between first and second positions and along a path extending in the same general direction as said thread forming elements, mechanism for feeding a fastener blank between said dies each time said movable die is in said first position, means mounting said stationary die on said support for selective adjustment relative to said movable die, said mounting means comprising a member carrying said stationary die and mounted on said support to swing about a pivot element having an axis extending substantially perpendicular to said path and coinciding substantially with the effective leading edges of the thread forming elements of said stationary die thereby to enable adjustment of the squeeze angle between said dies, and means for selectively swinging said member back and forth about said axis and for locking said member in a fixed position relative to said axis.

6. A thread rolling machine as defined in claim 5 in which a hole is formed through said member at a location spaced from said axis, a pin rigid with said support and projecting into said hole, said last-mentioned means comprising a pair of elements adjustably threaded into said member and engageable with said pin.

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