May 26, 1953 H. R. CHEEK 2,639,757

APPARATUS FOR FORMING METAL ARTICLES

Filed March 25, 1946 4 Sheets-Sheet 1

Fig. 1

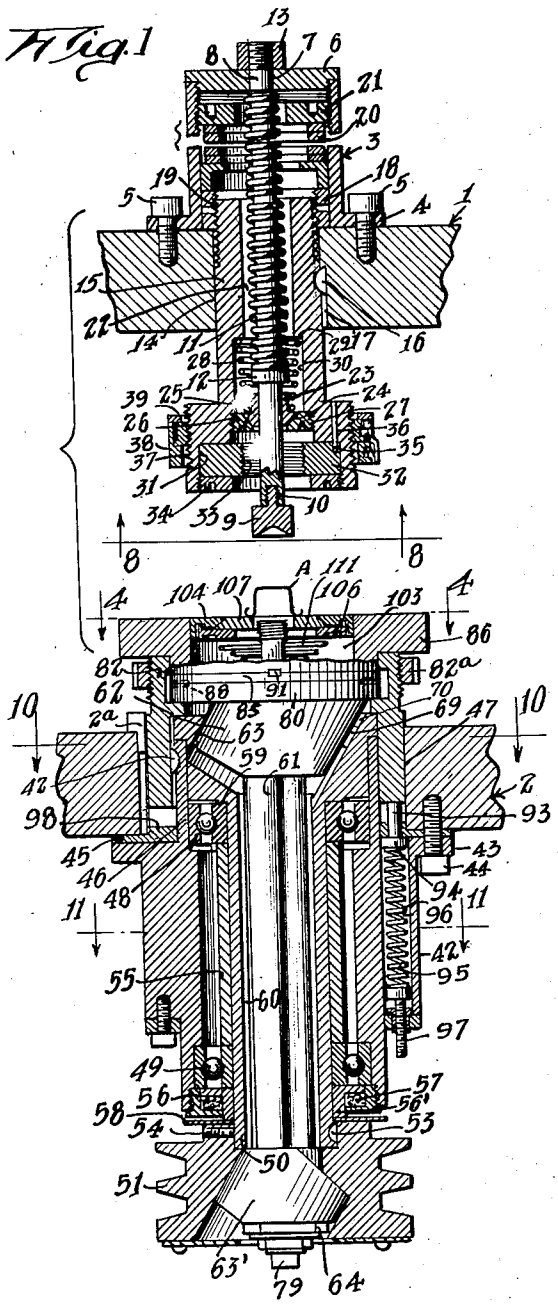


Fig. 4

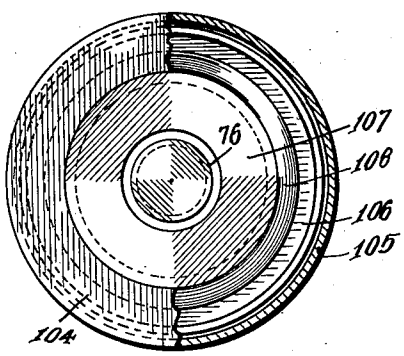


Fig. 5

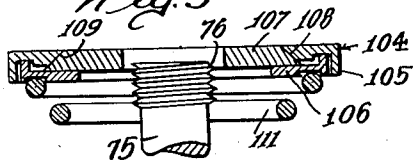
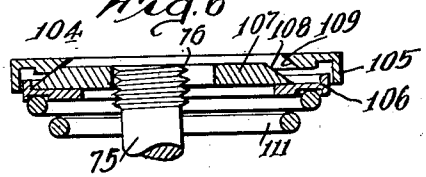


Fig. 6



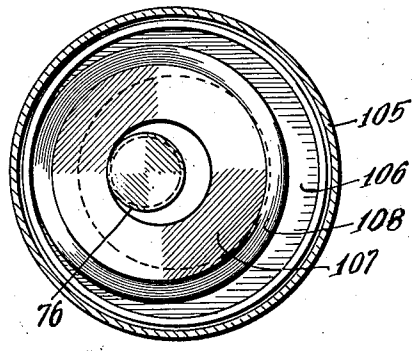


Fig. 7

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May 26, 1953 H. R. CHEEK 2,639,757

APPARATUS FOR FORMING METAL ARTICLES

Filed March 25, 1946 4 Sheets-Sheet 2

Fig. 2

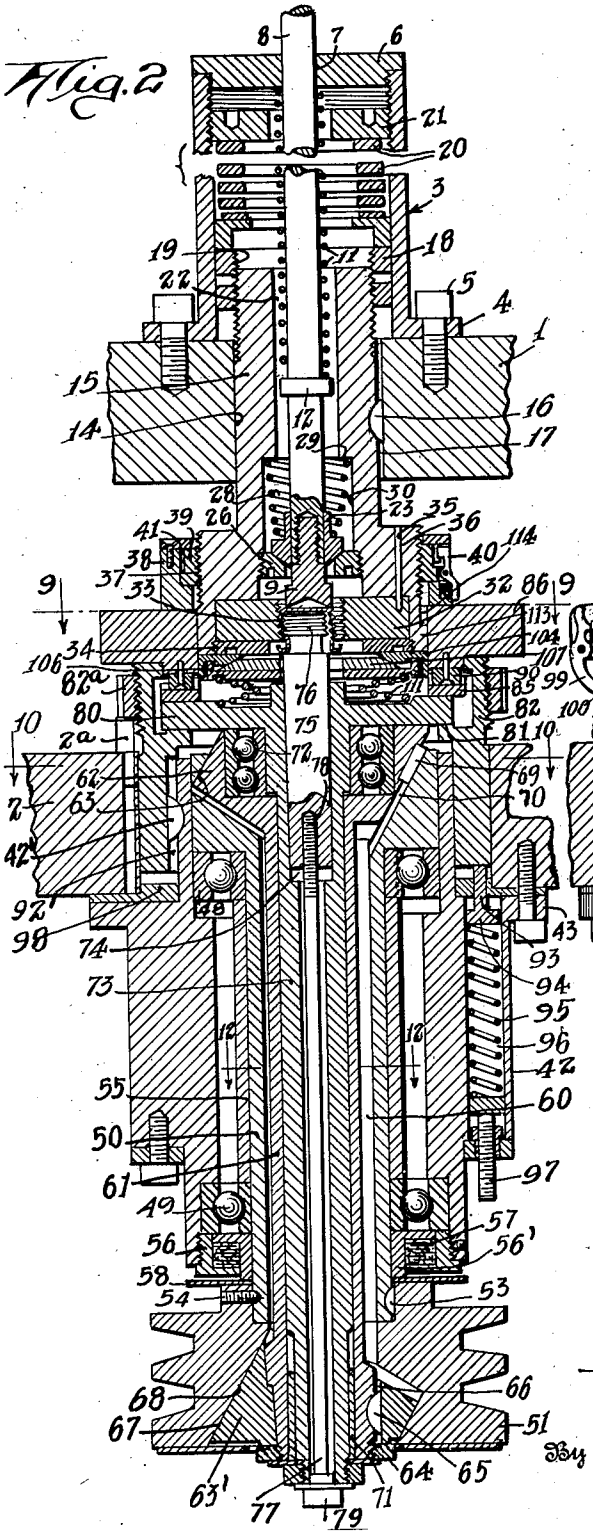
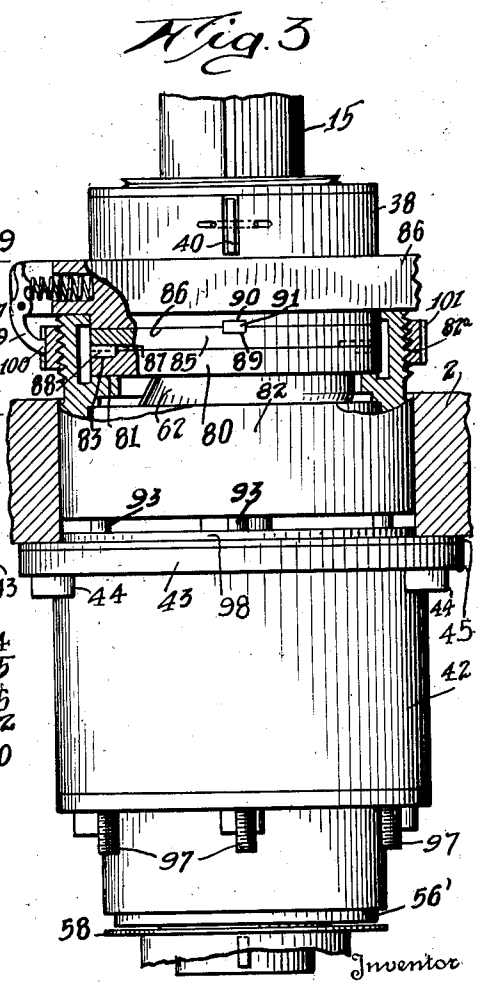


Fig. 3



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May 26, 1953 H. R. CHEEK 2,639,757

APPARATUS FOR FORMING METAL ARTICLES

Filed March 25, 1946 4 Sheets-Sheet 3

Fig. 8

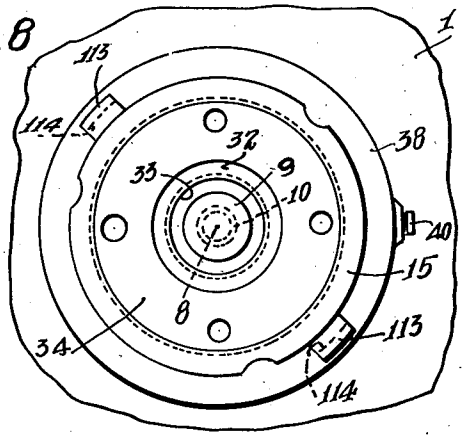
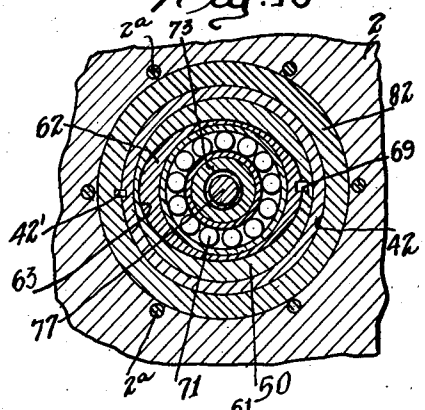


Fig. 10



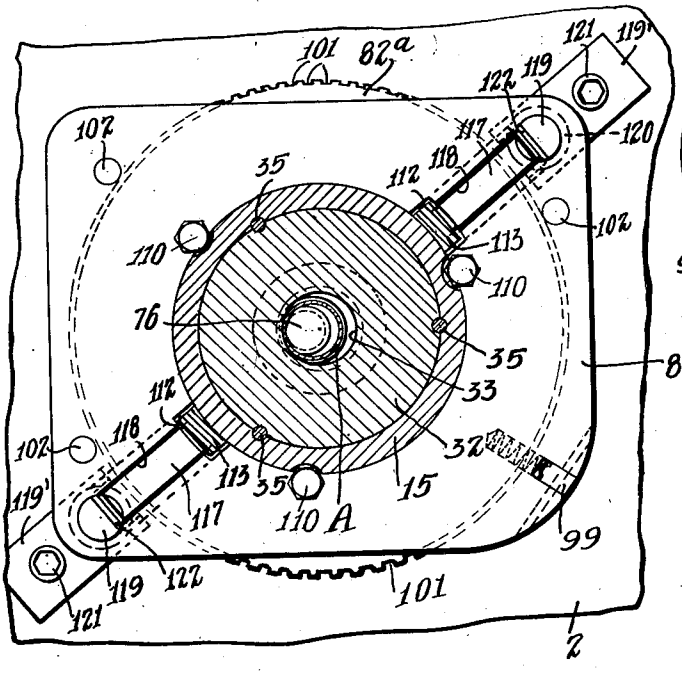


Fig. 9

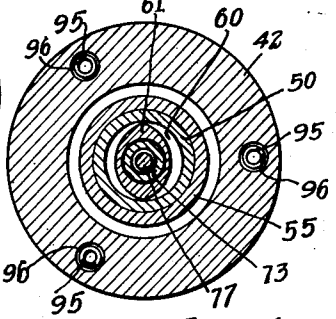


Fig. 11

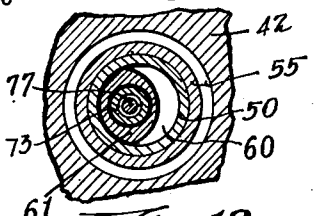


Fig. 12

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May 26, 1953 H. R. CHEEK 2,639,757

APPARATUS FOR FORMING METAL ARTICLES

Filed March 25, 1946 4 Sheets-Sheet 4

Fig. 13

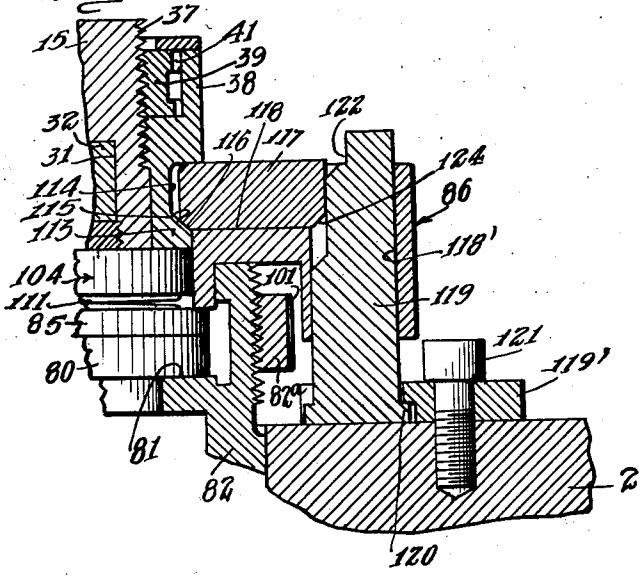


Fig. 14

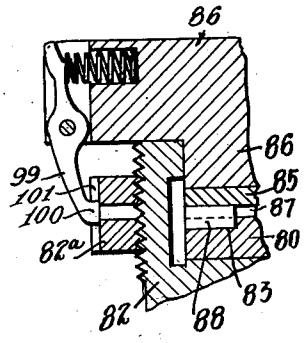


Fig. 15

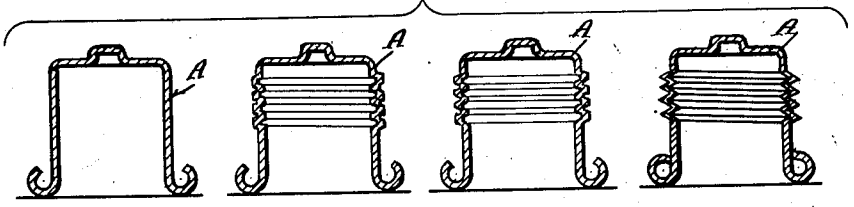
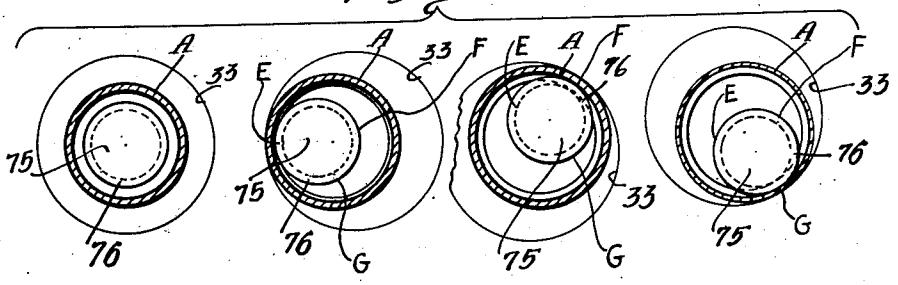


Fig. 16



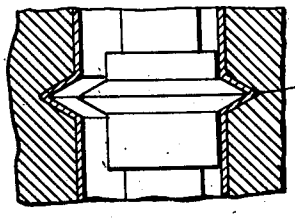


Fig. 17

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UNITED STATES PATENT OFFICE

2,639,757

APPARATUS FOR FORMING METAL ARTICLES

Hiram R. Cheek, Bell, Calif.

Application March 25, 1946, Serial No. 656,869

15 Claims. (Cl. 153—71)

1

This invention pertains to an apparatus for forming metal articles and particularly to an apparatus for threading, embossing, trimming, knurling, or otherwise forming metal articles, as well as burnishing or polishing the articles if and when such an operation is desired.

For illustrative purposes, the device shown is directed to the forming of threads on relatively thin-walled metal closure caps, although the invention is not limited thereto.

Heretofore, there has been considerable difficulty experienced in forming thin-walled metal closure caps or like articles, and particularly that type of closure cap provided with threads for engaging the threads of other threaded parts. Such difficulty has arisen primarily from the fact that in forming the threads on the closure cap, the apices of the threads are so thinned and have such a small amount of metal that the cap will fracture at the apices either before or after the cap is used. In accordance with the present invention, an apparatus is provided by which the walls of the cap at the threaded portion thereof will be of substantially the same thickness throughout the entire area of the threaded portion, and particularly at the leading and lagging sides, as well as the apices of the threads. By the term "leading and lagging sides" of a thread as used herein is meant the oppositely next adjacent angularly disposed surfaces defining a thread, such surfaces terminating at the apex of the thread. This is accomplished by cold flowing the metal in such manner that the leading and lagging sides of the threads will be formed of a given thickness with the metal being extruded or caused to flow by the forming operation towards the apices of the threads so that when the threads are completely formed, the sides and apices of the threads will be of substantially the same thickness. Further, the apparatus here disclosed is such as to produce threads of substantially the same wall thickness throughout the threaded area without change in the other dimensions of the article being formed.

In accomplishing this result, an apparatus is provided which is adapted for use with a parent machine such as a punch press or the like in which a reciprocating and a rotary motion both may be provided whereby the article to be formed may be moved into and out of the desired position with respect to forming dies, and an orbital motion of at least one of the forming dies with respect to the other forming die may be had to accomplish the forming of the article.

One object of the invention is to provide an

2

apparatus for threading, embossing, trimming, knurling or otherwise forming metal articles of such nature that the articles may be formed by a single machine operation and in a minimum of time.

Another object of the invention is to provide an apparatus of the character herein disclosed, and by means of which the threads, embossed areas, or knurled areas are of substantially the same thickness throughout and have a maximum strength, and are free of spots or areas of weakness due to insufficient metal being left at any one point by reason of the forming operation.

Another object of the invention is to provide an apparatus of the character and for the purpose herein disclosed wherein the die elements are of such relative diameter that during the forming operation, the die elements will cooperate to effect a wiping or slipping action such as to produce flow or extrusion of the metal, as well as forming the article progressivelly from substantially point contact rather than forming the entire formed area at one operation.

Another object of the invention is to provide an apparatus of the character herein disclosed which is positive in operation, simple in construction, and which will perform a plurality of operations on a single metal article simultaneously.

Various other objects and advantageous features of the invention may be had from the following description, and one embodiment thereof may be seen in the accompanying drawings wherein similar characters of reference designate corresponding parts, and wherein:

Fig. 1 is a view, principally in section, showing an apparatus for forming metal articles embodying the ideas of this invention and with the parts thereof in non-forming position.

Fig. 2 is a view similar to Fig. 1 but on an enlarged scale and showing the parts of the apparatus in cooperative forming position.

Fig. 3 is a view, principally in elevation but partly in section, of a portion of the apparatus shown in Fig. 2.

Fig. 4 is a top plan view taken on the line 4—4 of Fig. 1 without the encircling plate 86.

Fig. 5 is a sectional view showing the support for the article to be formed and corresponds to a transverse sectional view through the assembly shown in Fig. 4.

Fig. 6 is a view, similar to Fig. 5, but showing the article support in a different position.

Fig. 7 is a top plan view, similar to Fig. 4, of the article support as shown in Fig. 6.

Fig. 8 is a view taken on the line 8—8 of Fig. 1.

Fig. 9 is a sectional view taken on the line 9—9 of Fig. 2.

Fig. 10 is a view taken on the line 10—10 of Fig. 2.

Fig. 11 is a view taken on the line 11—11 of Fig. 1.

Fig. 12 is a view taken on the line 12—12 of Fig. 2.

Fig. 13 is an enlarged view of the locking means which controls proper cooperative positioning of the forming heads and corresponds to a transverse sectional view through the structure shown in Fig. 9.

Fig. 14 is an enlarged view of the locking means for securing the adjustable ring 82A which determines the degree of relative movement of the forming heads to bring the dies into proper forming position.

Fig. 15 is a view illustrating the successive degrees of forming on an article to be formed.

Fig. 16 is a view showing the movement of one forming die relative to the other.

Fig. 17 is a view further illustrating the method of forming as disclosed by this invention.

Referring to the drawings, the apparatus consists of a movable head 1 forming a part of the parent machine, and supporting a die carrying element, and a stationary head 2 forming a part of the parent machine and carrying a movable die element. Suitable means (not shown) are provided in the parent machine for producing reciprocatory movement of the movable head 1 to bring the die elements into cooperative relationship for forming of an article positioned therebetween. This apparatus may be mounted on or used with any suitable type of parent machine.

The die carrying element mounted on the movable head 1 of the parent machine consists of a cylinder 3 having a flange 4 by which the cylinder 3 is secured to the movable head 1 as by means of machine screws 5. The uppermost end of the cylinder 3 is provided with a removable cap 6 screw threaded into the top of the cylinder and having a central bore 7 for receiving a reciprocable rod 8 which carries on its bottom end a head 9 for engaging the part to be formed. Such head 9 may be of any suitable shape and is removable from the rod 8 so that substitution of heads of different size and shape may be made as desired by being screw threaded into the lower end of the rod 8 as at 10.

The head 9 is resiliently held in its full down position by a spring 11 interposed between the under side of the cap 6 and an annular shoulder 12 on the rod 8, downward movement of the rod 8 and head 9 being limited by a cap 13 screw threaded on the top end of the rod 8 and of such diameter as to bear against the upper face of the cap 6 when the rod 8 is in its down position.

Extending through a bore 14 in the movable head 1 of the parent machine is a sleeve 15, such sleeve 15 being held against rotary movement with respect to the movable head 1 by a key 16 carried by the sleeve and interfitting with a keyway 17 in the movable head 1, but being capable of vertical movement with respect to the movable head 1. Downward movement of the sleeve 15 is limited by a nut 18 engaging with threads 19 on the uppermost end of the sleeve 15, and the sleeve 15 is resiliently urged toward its down position, where the nut 18 bottoms on the upper side of the movable head 1, by a spring 20 which is interposed between the top of the nut 18 and an adjustable nut 21 contained within the cylinder 3, and which latter nut may be adjusted to vary the compression forces and the resistance of the spring 20.

The rod 8 carrying the head 9 extends downwardly through the bore 22 of the sleeve 15 and has mounted thereon a bushing 23 having an angular face 24 cooperating with the angular face 25 on a bushing or pad 26, which is screw threaded into the bore of the sleeve 15 as at 27. Such bushing 23 is resiliently urged into seated relationship with the bushing or pad 26 by means of a spring 28 interposed between a shoulder 29 formed by an enlarged bore 30 in the sleeve 15 and the top of the bushing 23. The angular surface of the bushing 23 cooperates with the angular surface of the bushing or pad 26, such surfaces being urged together by the spring 28 serves to center the rod 8 within the central bores of the sleeve 15.

In an enlarged bore 31 in the lower end of the sleeve 15 is mounted what in this instance is an annular die element 32 having a die face 33 for forming threads in a metal cap, although it is understood that the die face may be of various configurations or contours as desired. The die 32 is held within the enlarged threaded lower end of the enlarged bore 31 by a nut 34, and the die 32 is positioned in a predetermined position within the enlarged bore by a pin 35 which cooperates with an opening 36 in the sleeve 15 and an opening in the top of the die element 32. It will be understood that the head 9 of the rod 8 is of such size as to pass upwardly through the die, as will be hereinafter described.

As shown in Figures 1 and 3, the enlarged lowermost end of the sleeve 15 is externally threaded as at 37 to receive a ring 38 carried by a nut 39, and which nut 39 is adjustable to vary the position of the bottom surface of the ring 38 with respect to the lower surface of the enlarged end of the sleeve 15, and therefore the distance which the sleeve 15 moves into the lower head as and for the purpose hereinafter described. To lock the nut 39 and ring 38 in adjusted position there is provided a spring-pressed finger 40 (Figs. 2 and 3), one end of which normally engages grooves 41 in the nut 39 to lock the nut against rotation relative to the ring but which may be disengaged from such grooves to permit adjustment of the nut and the ring. It is noted that the ring 38 is swivelly connected to the nut and so rotates on sleeve portion 37. The pawl 40 locks the nut 39 and ring 38 against relative rotation and since both the ring 38 and nut 39 are threaded on the sleeve portion 37, the ring and nut form a lock nut combination to prevent their joint movement on the sleeve portion 37 when the pawl 40 engages grooves 41 in the nut 39.

Mounted in the lower stationary head 2 of the parent machine is a sleeve 42 (Fig. 11) having a flange 43, by which the sleeve is secured to the under side of the stationary head 2 as by means of machine screws 44. Interposed between the flange 43 and the bottom face of the head 2 is an annular bushing 45, the purpose of which will be hereinafter described. The sleeve 42 has a reduced neck portion 46 extending upwardly into a bore 47 in the stationary head 2. Mounted in the internal bore of the sleeve 42 is an upper bearing 48 and a lower bearing 49 in which a sleeve 50 rotates, and secured to the lower end of the sleeve 50, which extends beyond the bottom end of the sleeve 42, is a pulley or other means 51 for connecting a source of power thereto, such

pulley being secured to the sleeve 50 as by means of a key 53 interfitting with a keyway in the pulley, as well as set screw 54 of which there may be any desired number. The bearings 48 and 49 are held in proper spaced relation by a spacer bushing 55, and there is a bushing 56 threaded into the lower end of the sleeve 42 for holding the bearing 49 and providing a bore for a suitable grease retainer 57, and there is a spacer bushing 56' positioned between the bearing 49 and a slinger ring 58 which carries any leakage away for deposit in a suitable receptacle (not shown). The upper bearing 48 is positioned against a shoulder 59 on the upper end of the sleeve 50.

Mounted in the bore 60 of the sleeve 50 is a sleeve 61. As shown in Figures 11 and 12, the sleeve 61 is of considerably less diameter through its medial portion than the internal diameter of the bore 60 of sleeve 50, such differences in diameter being provided so that the sleeve 61 may be moved eccentrically of the bore 60, as will be hereinafter described. The upper end of the sleeve 61 is enlarged and shaped to provide a cam member 62, which coacts with a cam surface 63 formed internally in the upper end of the sleeve 50. At the lower end of the sleeve 61 there is provided a cam member 63' (Figures 1 and 2) which is maintained on the lower end of the sleeve 61 by a nut 64, and which is keyed to the lower end of the sleeve 61 by a key 65 (Figure 2) carried by the sleeve and cooperating with a keyway 66 in cam 63'. This cam 63' has a cam surface 67 cooperating with a cam surface 68 provided internally of the driving pulley 51. Thus, vertical movement of the sleeve 61 will produce an eccentric positioning of the sleeve 61 with respect to the internal bore 60 of the sleeve 50 as clearly illustrated in Figs. 2 and 12. The upper end of the sleeve 61 is keyed to the sleeve 50 by means of a key 69 which cooperates with a keyway 70 in the upper end of the sleeve 50 to secure the sleeves 61 and 50 together for simultaneous rotation, such mounting at the same time permitting a vertical movement of the sleeve 61 with respect to the sleeve 50, since the keyway 70 is angularly disposed on the same plane as the face of the cam 63.

Mounted in bearings 71 and 72 within the sleeve 61 is a rod 73, Figures 2 and 11, the rod 73 being so mounted as not to be rotated by rotation of the sleeve 61. The rod 73 moves into and out of eccentric relation with respect to the driven sleeve 50 with like movement of the sleeve 61 whereby rotation of the sleeves 50 and 61 and eccentric positioning of the sleeve 61 and the rod 73 will produce an orbital movement of the rod 73. The rod 73 has an opening 74 in the top thereof to receive a die member 75 having a die configuration 76 on one end thereof, the die member being held in the opening 74 by a wedging action produced between the opening 74 and the die member 75 through tightening an arbor 77 extending upwardly through the rod 73 and screw threaded into the die member 75 as at 78, the arbor 77 being provided on its lower end with a nut 79 so that it may be tightened by the use of a suitable tool.

The uppermost end of the rod 73 has an annular enlarged portion 80 which rests upon an annular shoulder 81 on a ring 82. This annular enlarged portion 80 is so held that it and the other attached rod 73 may move universally laterally in any direction i. e. radially with respect to the axis of rod 73, but is held against rotative movement. As shown, the annular enlarged portion 80 is provided with two keyways 83 (Figs. 14 and 3) on its upper side, such keyways being diametrically oppositely disposed 180° from each other. An annular ring 85 is positioned between the upper side of the annular portion 80 and the under surface of a plate 86 forming a part of the ring and is provided with keyways 87 matching the keyways 83. Keys 88 interfit with the matching keyways 83 and 87. Disposed in the upper surface of the ring 85 and the under surface of the plate 86, but located 90° from the keyways 83 and 87, are keyways 89 and 90 (Fig. 3), receiving keys 91. Thus, the annular enlarged portion 80 may move laterally universally, i. e. radially, in any direction i. e. with respect to the axis of rod 73, but is held against rotative movement with respect to the axis of rod 73 since the stationary sleeve 42 and ring 82 are held against relative rotative movement by a key 42' carried by the sleeve 42 and interfitting with a keyway 92 in the ring 82.

The ring 82 rests upon the upper end of a plurality of pins 93 which are annularly spaced, as shown in Fig. 2 and Fig. 3, and which extend upwardly through the bushing 45 disposed between the sleeve 42 and the stationary head 2. The pins 93 have shoulders 94 which limit their upward movement and these pins are urged towards their uppermost position by springs 95 disposed in bores 96 in the sleeve 42 and resting on the upper end of threaded screws 97 which may be adjusted upwardly or downwardly to vary the compression resistance of the springs 95. Such spring and pin arrangement resiliently holds the ring 82 in its upward position but permits downward movement thereof under pressure. The annular bushing 45 has an annular raised portion 98 to hold such bushing against lateral movement.

The uppermost end of the ring 82 is threaded to receive an internally threaded ring or nut 82^a (Fig. 14) which is adjustable upwardly or downwardly on the ring 82 to control the limit of downward movement of the ring 82 with respect to the sleeve 42 by bottoming on contacting pins 2^a (Fig. 2) disposed in annular spaced relation around the bore in the stationary head 2. Such adjustment determines the degree of orbital movement of the male die as hereinafter described. A locking means (Figs. 3 and 14) for maintaining the ring or nut 82^a in adjusted position is provided, this locking means consisting of a spring-pressed finger 99 carried by the ring 86, and having an end 100 adapted to be urged into engagement with grooves 101 on the outer circumferential surface of the ring or nut 82^a.

The plate 86 is secured to the upper end of the ring 82 by screws 102 (Fig. 9) and has a central bore 103 in which is disposed the support for the article to be formed. Such support (Figs. 1, 2, 5, and 6) comprises a centrally apertured plate 104 fitting within the central bore of the ring 86 and having a downturned flange 105 at its outer circumference to form a receptacle for a centrally apertured plate 106. Disposed between the plates 104 and 106 is a centrally apertured plate 107, Fig. 5, having a beveled edge 108 which cooperates with a bevel 109 on the ring 104. The entire assembly is limited in its upward movement by screws 110 (Fig. 9) and is urged toward its uppermost position by a spring 111 in the bore 103 and disposed between the under side of the plate 106 and the upper surface of the enlarged annular portion 80 of the rod 73. The article A to be formed rests on the intermediate plate 107, and the male die 75 extends into the aligned

central apertures in the plates. Since the intermediate plate 107 may freely move laterally universally in any direction when the parts are in operating position, as hereinafter described, the article and its support will follow the orbital path of the male die element so that the article to be formed will be in substantially point contact with the female and male dies.

To prevent misalignment of the male and female dies 75 and 32 and maintain the dies in alignment, as well as to prevent breakage or injury to the machine parts, should all parts not be in proper position to operate or be operated upon when the upper head and die carrying element is moved into or toward cooperative relation, the central bore of the plate 86 is provided with two vertically disposed grooves 112 (Fig. 9). The ring 38 carried by the enlarged lower end of the sleeve 15 is provided with diametrically opposed depending ears 113 adapted to fit into the grooves 112 if the upper and lower heads are in proper alignment. Each tongue or ear 113 is provided with a notch 114 having a cam surface 115 for cooperation with a cam surface 116 on a sliding key 117 mounted for horizontal sliding movement in ways or T-slots 118 in the plate 86 and normally held out of engagement with the notches 114 in the ears 113 by suitable means (not shown). Positioned in vertical openings 118' in the plate 86 are pins 119 held down by clamps 119' engaging flanges 120 on the bottom of the pins the clamps 119' being secured to the lower head 2 of the parent machine by machine screws 121. The upper end of the pins 119 are provided with cam surfaces or stepped portions 122. Should the parts be in proper alignment, the keys 117 will be moved inwardly by the engagement of a cam surface 124 on the keys 117 until they engage the notches 114 in the ears 113, as shown in Fig. 13, thereby locking the die carrying elements together. However, should the parts not be in proper aligned relation, the keys will be prevented from moving into the notches 114, and the parts cannot then move into cooperative relation, and the dies will be held in non-operating position by the keys bottoming on top of the pins 119.

Should the parts not be in proper aligned relation and held apart as hereinbefore described, provision is made to prevent breakage of the parts by pressure exerted between the movable heads 1 and 2 of the parent machine. In such an event, the sleeve 15 will be moved upwardly against the resistance of the spring 20 and the rod 8 will be moved upwardly against the resistance of the spring 11. This resilient mounting will obviously prevent breakage of parts. Also, such resilient mounting permits the use of the forming apparatus in parent machines which have harmonic motion, giving sufficient time for the forming action.

In the operation of the apparatus and the performance of the method, assuming the parts to be in the unoperative position, as shown in Figure 1, an article A to be formed is placed upon the plate 107 over the central aperture therein as shown. Then, the head 1 with its associated die-carrying element is moved towards the head 2 and its associated die-carrying element to bring the parts of the apparatus into position for forming the part A between the female die member 32 and the male die member 75.

As the head 1 moves towards the head 2, the pad 9 contacts the part A to hold it in position, and continued movement of the head 1 towards the head 2 causes the enlarged lower end of the sleeve 15 to contact the plate 104 and move the plate 104 and its associated plates downwardly against the resistance of the spring 111, such downward movement bringing the die element 32 into cooperative aligned position with the die element 75, the part A being disposed between the die elements.

The head 1 continues to move toward the head 2 until the ring 38 bottoms on the top of the plate 86 and produces a downward movement of the ring 86 and the parts carried thereby, including the sleeve 61 and rod 73, and movement of the cams 60 and 63 along the cam surfaces 63' and 67 to move the sleeve 61, the rod 73, and the male die 75 eccentrically of the bore 60 of the rotatable sleeve 50. Assuming all of the parts to be in proper aligned position, the tongues 113 on member 15 (Fig. 8) enter the vertical grooves 112 in the bore of plate 86 and the keys 117 are moved horizontally by the cam surfaces on the pins 119 on plate 86, as shown in Fig. 13, to lock the parts in the operative position, shown in Fig. 3. After the parts are thus locked in operative position, the plate 86, die 32, rod 73, die 75, and sleeve 61 are forced downward in unison by further movement of the head 1, the cams 62 and 63' acting to move the sleeve 6, the rod 73 and the male die 75 eccentrically of the rotatable sleeve 50 with the result that the die 75 is brought into active cooperative relationship to the die 32. It being understood that the sleeve 50 is continuously rotating, as is the sleeve 61, while the rod 73 and the male die are not rotating, such eccentric positioning will cause the male die to move in an orbital path relative to the female die. This is clearly shown in Figs. 3 and 16 wherein the regions designated E, F and G on the die member 75 serve to illustrate the fact that the die member 75 in its orbital movement does not rotate about its own axis and yet different portions of the die 75 contact the work A. It is noted that the rotation of the die 75 about its own axis and turning movement of the die 75 relative to the female die structure is prevented by the keys 88 and 91, and that, as a result, the regions E, F and G on the die member maintain their angular positions as shown in Figure 16. Downward movement of the sleeve 82 is limited by the ring 82^a bottoming on the annularly spaced pins 2^a.

As clearly shown, the die face 33 of the female die 32 is greater in diameter than the diameter of the male die surface 76. Thus, when the male die is moved eccentric to the female die, it carries the part A to be formed with it into engagement with the forming surface of the female die, and results in a minimum angle of incidence between the dies for forming of the part A between the dies. This is clearly illustrated in Fig. 16. Such arrangement and action between the dies also produces a forming by a sliding and wiping action, and in a progressive manner. In Fig. 15 is shown the forming of the threads to successively greater depths by the cooperative action between the dies hereinbefore described.

To overcome the difficulty heretofore experienced in having the apices 109 of, for example, threads produced on the formed part being so thin as to fracture, in accordance with this invention, the forming surfaces of the male and female die elements are so formed and the surfaces thereof which produce the leading and lagging sides of the threads are of such relative angularity and form, and the male member producing a wiping action on the article such that

cooperative action of die elements will first form the leading and lagging surfaces in such manner that a part of the metal in the part being formed will be flowed or extruded toward the apex of the thread so that when the thread is completed, the apex will be of the same thickness as that of the leading and lagging surfaces. This is evident from a consideration of the wiping or orbital movement of the male die member illustrated in Figs. 16 and 17 wherein the apex of the male die member is more or less rounded or dull and the cross sectional area of the forming portion of the male die element is such with respect to the cross sectional area of the forming portion of the female die element as to initially simultaneously produce a forming extrusion or crowding of the metal defining the leading and lagging surfaces toward the apex of the thread. Subsequent wiping action of the male die member in the final stage causes the rounded portion of the male die member to be more effective in expanding the metal previously extruded or crowded in the vicinity of the apex. By the use of this apparatus and method wherein the metal is shaped by a sliding and wiping action, produced by the orbital movement of the male die member in a progressive manner with respect to the circumferential area of the article to be formed, it is possible to form the article with the expenditure of a minimum amount of power, force and effort.

Upon release or upward movement of the part 1 of the parent machine, the parts are returned to their normal inoperative position shown in Fig. 1 by means of the various spring members hereinbefore described.

Having fully described my invention, it is to be understood that I do not wish to be limited to the details herein set forth, but my invention is of the full scope of the appended claims.

I claim:

1. In a forming device, the combination comprising a pair of heads movable toward and away from each other, a die member carried by each of said heads, means arranged to automatically move said die members into and out of cooperative relation upon relative movement of said heads, a stationary supporting structure for one of said die members, means mounted on said supporting structure arranged to move said one die member with an article pinched therebetween in an orbital path relative to the other die member to produce on said article to be formed the configuration of the dies, means rotatably supporting said one die member on the last mentioned die moving means, means maintaining a fixed angular relationship between said one die member and said supporting structure in movement of said one die member through said orbital path, the other die member being mounted in fixed angular relationship to said supporting structure.

2. In a forming device, the combination comprising a pair of heads movable toward and away from each other, a die member carried by each of said heads, means arranged to automatically move said die members into and out of cooperative relation by relative movement of said heads, said die members being normally mounted concentric and one of said die members being movable into a position eccentric to the other die member upon actuation of the last mentioned means, a stationary supporting structure for said one die member, means mounted on said supporting structure arranged to produce movement of said one die member in an orbital path relative to the other die member with an article pinched therebetween to produce on said article to be formed the configuration of the dies, means rotatably supporting said one die member on the last mentioned die moving means, and means maintaining a fixed angular relationship between said one die member and said supporting structure, said other die member being mounted in fixed angular relationship to said supporting structure.

3. In an apparatus for forming metal articles, the combination comprising male and female forming dies normally positioned concentric with each other and movable relatively into and out of cooperative relation, a stationary supporting structure for said male die, means mounted on said supporting structure arranged to move said male die into eccentric relationship with said female die, means arranged to support an article to be formed in a position between said forming dies, and means effective upon operation of the first mentioned means arranged to move said male die in an orbital path relative to the other die with said article pinched therebetween to produce on said article to be formed the configuration of the dies, means rotatably supporting said male die on the last mentioned die moving means, means maintaining a fixed angular relationship between said male die and said supporting structure, said female die being mounted in fixed angular relationship to said supporting structure.

4. In an apparatus for forming metal articles, the combination comprising male and female forming dies each normally positioned concentric with each other and movable relatively into and out of cooperative relation, means arranged to support an article to be formed in a position between said forming dies, means arranged to move said male die to a position eccentric to the female die, a stationary supporting structure, means mounted on said stationary supporting structure for moving said male die in an orbital path relative to the female die with said article pinched therebetween to produce on said article to be formed the configuration of the dies, means rotatably supporting said male die on the last mentioned die moving means, and means maintaining a fixed angular relationship between said male die and said supporting structure, said female die being mounted in fixed angular relationship to said supporting structure.

5. In an apparatus for forming articles, the combination comprising a pair of dies each having one threaded portion which cooperates with the threaded portion on the other die and normally concentric with each other, one of said dies being lesser in diameter than the other, a supporting structure for said one die, means arranged to produce relative movement between said dies to move one within the other, means mounted on said supporting structure and actuated upon operation of the last mentioned means arranged to move the die of lesser diameter into a position eccentric to the other die with an article pinched therebetween, means for moving said one die of lesser diameter in an orbital path relative to the other die while maintaining a fixed angular relationship between said one die and said supporting structure, the other die being mounted in fixed angular relationship to said supporting structure.

6. In a forming device of the character described, a stationary supporting structure, a first rotatable sleeve rotatably mounted on said structure, a second sleeve mounted within said first sleeve for simultaneous rotation therewith and

for radial movement with respect thereto, means for moving said second sleeve radially and longitudinally with respect to said first sleeve, a die member carried by said second sleeve, means acting on said die member for maintaining a fixed angular relationship between said die member and said supporting structure but allowing rotation of said die member about the axis of said first sleeve, and resilient means acting between said first and second sleeves to normally bias said die member in a central position on the axis of rotation of said first sleeve, and a second die member arranged to coact with said first die member, said second die member being mounted in fixed angular relationship to said supporting structure.

7. In a forming device of the character described, a stationary supporting structure, a first rotatable sleeve rotatably mounted on said structure, a second sleeve mounted within said first sleeve for simultaneous rotation therewith and for radial and longitudinal movement with respect thereto, cam means disposed between said first and second sleeves and operated upon said longitudinal movement for positioning said second sleeve radially of said first sleeve, means acting on said die member for maintaining a fixed angular relationship between said die member and said supporting structure but allowing rotation of said die member about the axis of said first sleeve, an article supporting ring encircling said die member, and means resiliently mounting said ring on and for independent movement relative to said first sleeve, and a second die member arranged to coact with said first die member, said second die member being mounted in fixed angular relationship to said supporting structure.

8. In a forming device of the character described, a stationary supporting structure, an outer power driven sleeve rotatably mounted on said structure, an inner driven sleeve mounted within said outer sleeve for simultaneous rotation therewith, guide means between said inner and outer sleeves allowing guided movement of said inner sleeve both in its longitudinal direction and in a radial direction with respect to said outer sleeve, a die member mounted on said inner sleeve, means maintaining a fixed angular relationship between said die member and said supporting structure but permitting its movement in an orbital path about the axis of said inner sleeve, cooperating cam means between said inner and outer sleeves whereby said inner sleeve is moved radially with respect to said outer sleeve upon application of a force to said inner sleeve along its longitudinal axis, and a second die member arranged to coact with said first die member, said second die member being mounted in fixed angular relationship to said supporting structure.

9. In a forming device of the character described, a stationary supporting structure, an outer power driven sleeve rotatably mounted on said structure, an inner driven sleeve mounted within said outer sleeve for simultaneous rotation therewith, guide means between said inner and outer sleeves allowing guided movement of said inner sleeve both in its longitudinal direction and in a radial direction with respect to said outer sleeve, a die member mounted on said inner sleeve, means maintaining a fixed angular relationship between said die member and said supporting structure but permitting its movement in an orbital path about the axis of said outer sleeve, cooperating cam means between said inner and outer sleeves whereby said inner sleeve is moved radially with respect to said outer sleeve upon application of a force to said inner sleeve along its longitudinal axis, and resilient means acting between said outer and inner sleeves to normally bias said die member in a central position on the axis of rotation of said outer sleeve, and a second die member arranged to coact with said first die member, said second die member being mounted in fixed angular relationship to said supporting structure.

10. In a forming device of the character described, a stationary supporting structure, a first assembly comprising: an outer power driven sleeve rotatably mounted on said structure, an inner driven sleeve mounted within said outer sleeve for simultaneous rotation therewith, guide means between said inner and outer sleeves allowing guided movement of said inner sleeve both in its longitudinal direction and in a radial direction with respect to said outer sleeve, a first die member mounted on said inner sleeve, means maintaining a fixed angular relationship between said die member and said supporting structure but permitting its movement in an orbital path about the axis of said inner sleeve, cooperating cam means between said inner and outer sleeves whereby said inner sleeve is moved radially with respect to said outer sleeve upon application of a force to said inner sleeve along its longitudinal axis; a second assembly movable relative to said first assembly and axially aligned therewith, said second assembly comprising a second die member positionable to encircle said first die member, and means mounting said second die member and effective to move said inner sleeve radially with respect to said outer sleeve, said second die member being mounted in fixed angular relationship to said supporting structure.

11. In a forming machine of the character described, a stationary supporting structure, an outer power driven sleeve rotatably mounted on said structure, an inner driven sleeve mounted for movement in said outer sleeve in its longitudinal direction and in a radial direction with respect to said outer sleeve and for simultaneous rotation therewith, cooperating cam means between said inner and outer sleeve whereby an application of force to said inner sleeve along its longitudinal axis results in radial movement of said inner sleeve in said outer sleeve, a die member mounted on said inner sleeve, means mounting said die member on said inner sleeve whereby said die member is maintained in fixed angular relationship with respect to said supporting structure but permitting its bodily movement in an orbital path about the rotational axis of said outer sleeve, and adjustable stop means between said inner and outer sleeves for limiting the radial movement of said inner sleeve with respect to said outer sleeve and a second die member arranged to coact with said first die member, said second die member being mounted in fixed angular relationship to said supporting structure.

12. In a forming machine of the character described, a stationary supporting structure, an outer power driven sleeve rotatably mounted on said structure, an inner driven sleeve mounted for movement in said outer sleeve in its longitudinal direction and in a radial direction with respect to said outer sleeve and for simultaneous rotation therewith, cooperating cam means between said inner and outer sleeves whereby an application of force to said inner sleeve along

its longitudinal axis results in radial movement of said inner sleeve in said outer sleeve, a die member mounted on said inner sleeve, means mounting said die member on said inner sleeve, means whereby said die member is maintained in fixed angular relationship with respect to said supporting structure but permitting its bodily movement in an orbital path about the rotational axis of said outer sleeve, and adjustable stop means between said inner and outer sleeves for limiting the radial movement of said inner sleeve with respect to said outer sleeve, and resilient means acting between said outer and inner sleeves to normally bias said die member in a central position on the axis of rotation of said outer sleeve, and a second die member arranged to coact with said first die member, said second die member being mounted in fixed angular relationship to said supporting structure.

13. In a forming machine of the character described, a stationary supporting structure, a first assembly comprising: an outer power driven sleeve rotatably mounted on said structure, an inner driven sleeve mounted for movement in said outer sleeve in its longitudinal direction and in a radial direction with respect to said outer sleeve and for simultaneous rotation therewith, cooperating cam means between said inner and outer sleeves whereby an application of force to said inner sleeve along its longitudinal axis results in radial movement of said inner sleeve in said outer sleeve, a die member having a spiral screw thread die face mounted on said inner sleeve, means mounting said die member on said inner sleeve means whereby said die member is maintained in fixed angular relationship with respect to said supporting structure but permitting its bodily movement in an orbital path about the rotational axis of said outer sleeve, adjustable stop means between said inner and outer sleeves for limiting the radial movement of said inner sleeve with respect to said outer sleeve; a second assembly movable relative to said first assembly and axially aligned therewith, said second assembly comprising a second die member having a cooperating spiral screw thread die face positionable to encircle said first die member, means mounting said second die member and movable into engagement with said inner sleeve to move the same radially with respect to said outer sleeve, adjustable means for adjustably positioning said second die member on the last mentioned means whereby the screw threads on said first and second die members may be matched, said second die member being mounted in fixed angular relationship with respect to said supporting structure.

14. In a die forming machine of the character described, a stationary supporting structure, a first power driven sleeve rotatably mounted on said supporting structure, a second sleeve movable longitudinally with respect to said first sleeve and mounted for simultaneous rotation therewith, said first and second sleeves extending generally coaxially, a die member mounted on said second sleeve, said die member extending generally along the axis of said second sleeve, means whereby said die member is maintained in fixed angular relationship with respect to said supporting structure but yet is free to move to different eccentric positions with respect to the rotational axis of said first sleeve, cooperating cam means acting between said first and second sleeves whereby an application of force to said second sleeve results in both longitudinal and radial movement of said second sleeve with respect to said first sleeve to thereby move said die member to different eccentric positions with respect to the rotational axis of said first sleeve, abutment means acting between said first and second sleeves for limiting the longitudinal movement of said second sleeve whereby the eccentric position of said die member may be adjusted, and a second die member arranged to coact with said first die member, said second die member being mounted in fixed angular relationship to said supporting structure.

15. In a die forming machine of the character described, a stationary supporting structure, a first power driven sleeve rotatably mounted on said structure, a second sleeve movable longitudinally and radially with respect to said first sleeve for simultaneous rotation therewith, said first and second sleeves extending generally coaxially, a die member mounted on said second sleeve, said die member extending generally along the axis of said second sleeve, means mounting said die member on said second sleeve, means whereby said die member is maintained in fixed angular relationship with respect to said supporting structure but yet is free to move to different eccentric positions with respect to the rotational axis of said first sleeve, cooperating cam means acting between said first and second sleeves whereby an application of force to said second sleeve results in both longitudinal and radial movement of said second sleeve with respect to said first sleeve to thereby move said die member to different eccentric positions with respect to the rotational axis of said first sleeve, abutment means acting between said first and second sleeves for limiting the longitudinal movement of said second sleeve whereby the eccentric position of said die member may be adjusted, resilient means acting between said outer and inner sleeves to normally bias said die member in a central position on the axis of rotation of said first sleeve, and a second die member arranged to coact with said first die member, said second die member being mounted in fixed angular relationship to said supporting structure.

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