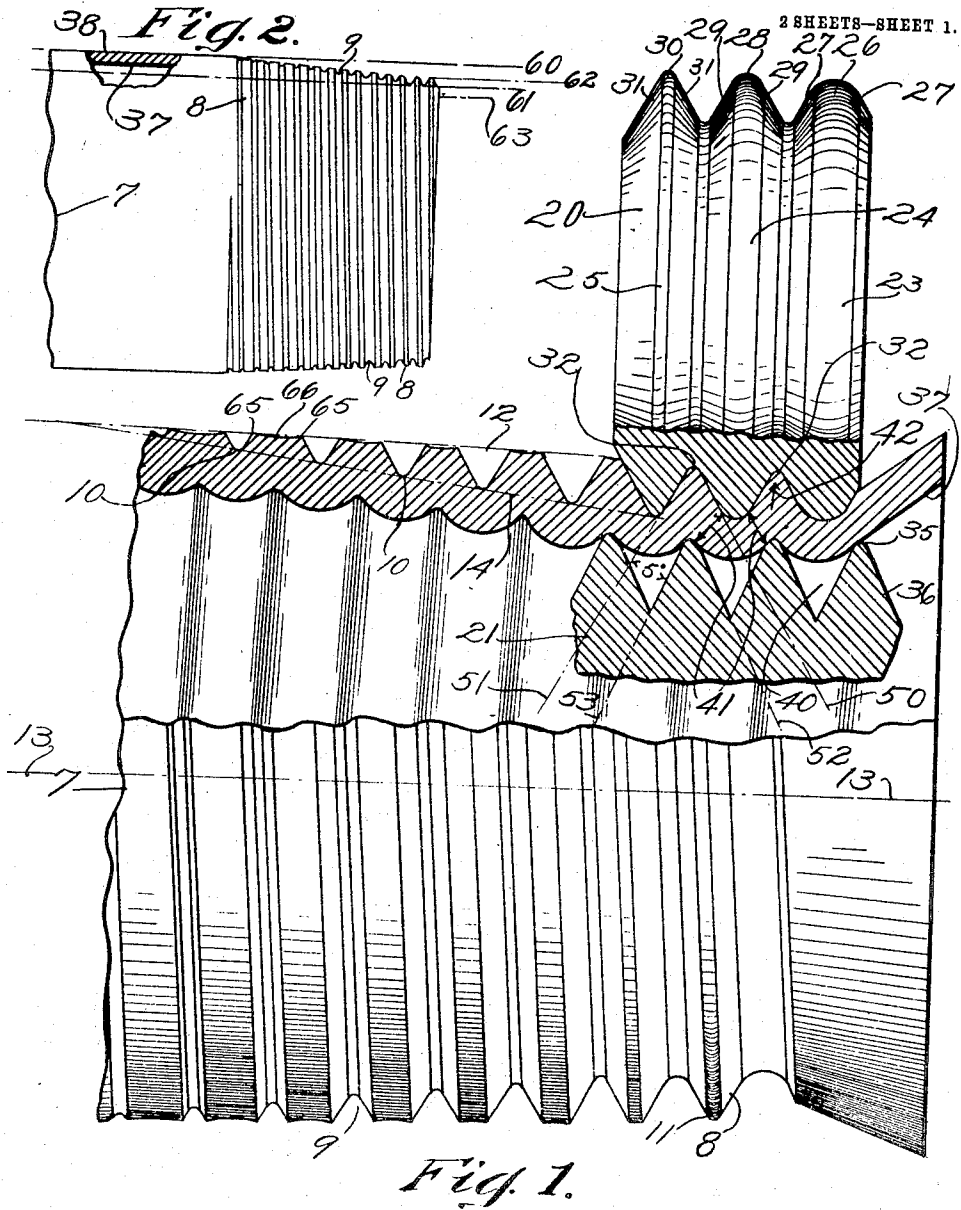


No. 859,643.

PATENTED JULY 9, 1907.

C. L. CUMMINGS.
ART OF PIPE THREAD FORMATION.

APPLICATION FILED MAR. 17, 1906.



Witnesses:

W. E. Lusk.

C. L. Russell.

Inventor:

Charles L. Cummings,

By his attorney,

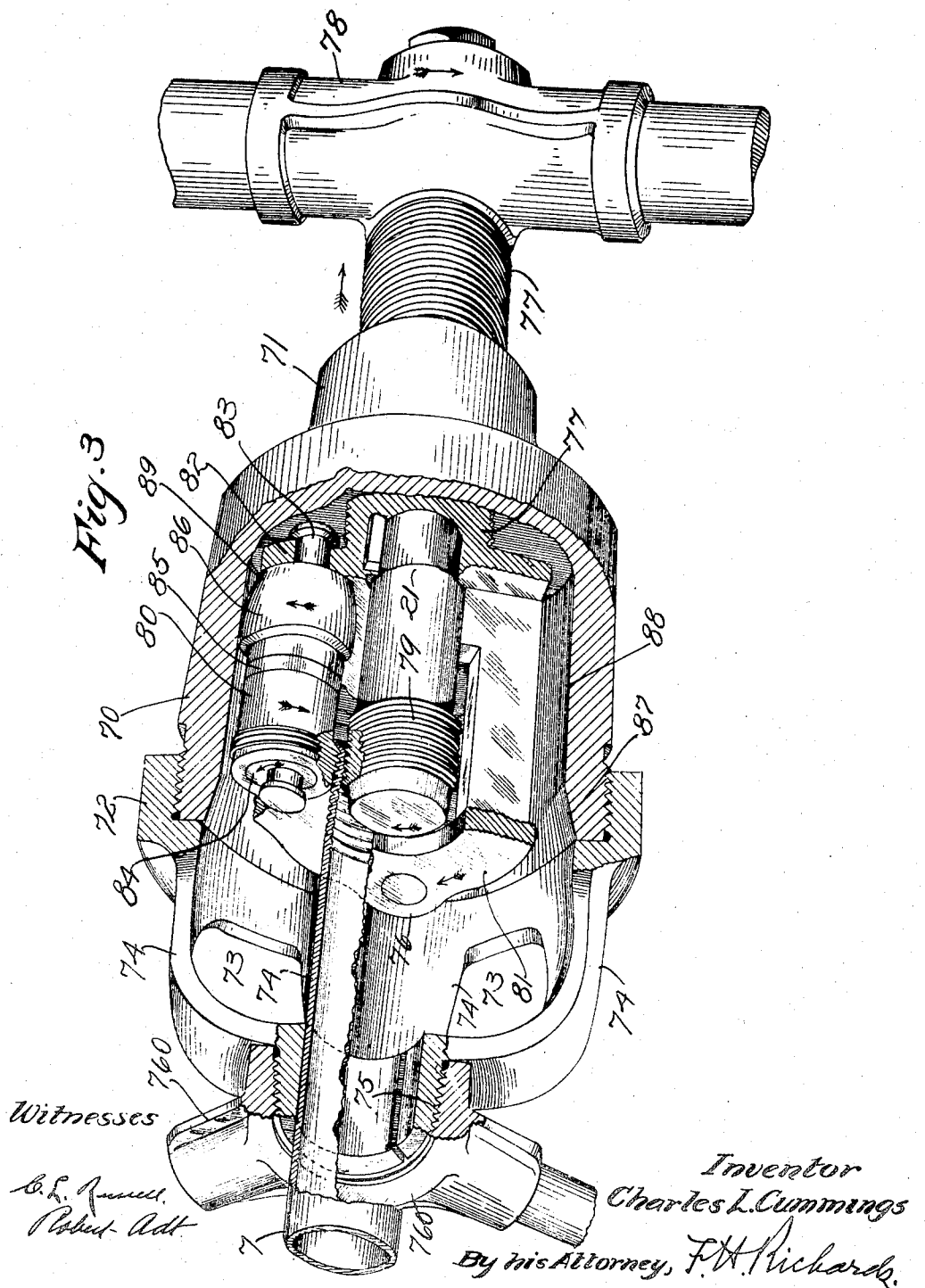
F. A. Richards.

No. 859,643.

PATENTED JULY 9, 1907.

C. L. CUMMINGS.
ART OF PIPE THREAD FORMATION.
APPLICATION FILED MAR. 17, 1906.

2 SHEETS—SHEET 2.



UNITED STATES PATENT OFFICE.

CHARLES L. CUMMINGS, OF NEW YORK, N. Y., ASSIGNOR TO CUMMINGS MACHINE COMPANY,
OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

ART OF PIPE-THREAD FORMATION.

No. 859,643.

Specification of Letters Patent.

Patented July 9, 1907.

Application filed March 17, 1906. Serial No. 306,508.

To all whom it may concern:

Be it known that I, CHARLES L. CUMMINGS, a citizen of the United States, residing in the city of New York, borough of Manhattan, in the county of New York and State of New York, have invented certain new and useful Improvements in the Art of Pipe-Thread Formation, of which the following is a specification.

This invention relates to the art of pipe thread formation, and has for an object to provide an improved method or process of forming pipe threads upon metal tubing, and is peculiarly adapted for forming by a forging or analogous treatment such threads upon tubing having comparatively thin walls.

One form of screw thread now known as a standard taper pipe thread has its face at about sixty degrees and the outside of the threaded tube end may be tapered at about the ratio of three-quarters of an inch to the foot, and the present improvement in the art presents an improved mode of production having in view an improved product, which product is set forth in my concurrently pending application Serial No. 308,464, filed March 28th 1906.

In producing thread formation according to these present improvements the operation may best be commenced at a point inward of the end of the tubing and the operation proceeded with step by step toward such end, the metal being gradually forged-up and caused to flow into position for forming proper screw threads without weakening the tube or materially altering the radial thickness of the walls thereof, particularly at the bottom of the thread forming groove, and when the taper effect is desired the wall of the tube will be tapered. The thread produced will be disposed in a conical helix, the convolutions of the thread gradually decreasing in diameter toward the end of the tube.

It is well known that the method which now exists for cutting screw threads upon tubing by means of dies weakens the tubing, in that the bottom of the thread forming groove approaches toward the inner face of the tube wall and as the outer diameter of the tube is reduced due to the taper given the threaded end, the inner diameter remaining unchanged, the bottom of the groove gradually enters the metal to such an extent and cuts away so much metal that it is impossible to put standard pipe threads, which of course includes in its meaning that the tube end is tapered exteriorly, upon tubing unless the same is considerably thicker than the height of the thread which is to be formed plus the taper of the tube wall, and enough in excess of such height and taper to leave a substantial body of metal below the bottom of the thread forming groove. This requires that the tubing employed shall, at times, be much heavier than

the requirements of its use may demand, so that after the cutting away of the tubing in making the thread forming groove it shall at such regions have sufficient strength to withstand strains and pressures to which the tubing is to be subjected. By my present improvement it is feasible to produce threads of a height radially approaching and even greater than the radial thickness of the tube, and to do this without reducing the tensile or the bursting strength of the tube. In the production of the thread, the tube will be worked upon and subjected to forging treatment, that is a treatment causing flowage of the metal or an active molecular redistribution, from and upon the outer and the inner sides contemporaneously at the same region of the thread being formed. Working or forging pressure will be applied to the outer side of the tubing to forge-up the metal or for forming the same by flowage into the shape of the desired thread, and co-operative working or forging pressure will at the same time be carried on upon the inner side of the same portion of the tube wall. Each portion may be subjected to a series of such working treatments, these being independently but successively applied, and the entire flowage and building up will be the net result of a plurality of distinct forging actions. The metal for constituting the thread will be engaged at points upon opposite sides of such thread, that is engaging opposite side faces thereof and pressing the metal so that this is caused to flow in a radial direction, both toward and from the axis of the tube. The flowing away action of the metal will be for building up the thread and for completing the apex thereof, and counter pressure will be applied to the metal to force portions of this in the opposite direction and inwardly of the tube at a point below the bottom of the thread forming groove, so that the metal will be forged and a flowage set up toward, beyond and about the region of the bottom of the groove for building up the metal and compensating for the displacement at such region due to the forging action upon the metal at the bottom of the groove. When reference is made to the metal flowing in a direction away from the axis of the tube, the fact is not lost sight of that the portion of the tube wall being acted upon is translated, as it were, toward the axis, and also in such translated portion, during and after its translation, the molecular flowage is taking place in different radial and other directions. In fact these references to directions of flowage are merely for the purpose of assisting the mind to arrive at a proper conception of the invention and when this is accomplished the mere relative direction of flowage becomes of minor importance in comparison with the general distribution and final arrangement of the whole body of metal within the portion of the tube treated.

This improvement may best be understood by recourse to the drawings accompanying and forming a part of this specification and wherein

Figure 1 is an enlarged elevational view of a tube end undergoing thread formation, this is broken away in a longitudinal line and shown in section with portions of the inner and outer tools in their co-operative relation. Fig. 2 is a view showing in side elevation a threaded tube end, a portion of its wall being broken through for exhibiting its thickness; and Fig. 3 is a perspective view of a tool or device which may be used in practicing the present improvement, parts of this are illustrated as broken away for showing the relative portions of the parts and their mode of operation, a section of tubing is shown in the bite of the tools. This tool is made the subject of my application, Serial No. 277,828 filed September 11, 1905, for threading tool.

The drawings herein are for the purpose of illustration only and are not to be considered as excluding other aids or assistants in practicing this improvement.

It will be seen by reference to Figs. 1 and 2 that a tube 7, in being provided with a taper thread 8, is gradually reduced in diameter, the thread helix is given a conical disposition, and the tube wall is tapered; the thread forging action will impart these formations substantially concurrently and as results of the same operation. The thread forming groove 9, see more particularly Fig. 1, gradually increases in depth, that is its bottom portion 10 is brought gradually nearer to the axis of the tube, as will be apparent from a comparison of the respective convolutions of the groove. The apex 11 of the thread gradually rises above the bottom portion 10 of the groove which also marks the root of the thread, it will be seen that the line 12 marking the apex of the thread indicates a taper to the axial line 13, but a less taper than the line 14 marking the line of the thread root and the bottom of the groove. These lines are not carried out in Fig. 1 to the region of the tools since to do so would tend to confuse other lines to be herein after referred to, and also because the thread at such region is not completed.

During the treatment to which the tube is subjected there is an action upon the tube wall at the region of working in the nature of an inward translation of the metal thereof. Of course there is at the same time co-operative treatment proceeding upon both faces of such "translated" portion, yet for the purpose of this portion of the description such term appears to be adequate. As the tube wall is forced inwardly the crest or apex of the thread is raised and the entering in of the rolls, which may be used in carrying out the treatment, in excess of their ability to build up the thread and swage the tube wall into a taper will displace metal and by the co-operative treatment carried on at the other side of the tube wall, this displaced metal will, in its flowage, be directed to such a position that it will build up the tube wall at the bottom of the thread forming groove. The thread is forged up from the normal plane of the translated portion, and at and beyond the point or line where the side faces of adjacent convolutions of the thread join, forming the bottom of the thread groove, the metal is forged up in the opposite direction from such plane; the forged-up metal upon one side of the tube wall constituting a thread, and the forged-up metal upon the other side thereof constituting, owing

to its disposition, a reinforce for the metal sustaining the bottom of the thread forming groove.

In Fig. 1 it will be seen that the tube wall is acted upon by an outer and an inner tool, 20 and 21 respectively; the outer tool being in the present instance in the form of a roller and having upon it a number of tools 23, 24 and 25. The tool 23 in the present instance is shown as having a rounding working face 26 for preliminarily breaking down the metal, and it will be this tool which is largely instrumental in the swaging or tapering of the tube wall, which has above been referred to as a translation of the metal, or a portion of the wall. This tool is also provided with faces 27 which are disposed approximately upon an angle of 60 degrees one to the other; this being the angle which has been selected for the thread illustrated herein. The tool 24 is shown as having a rounding crest 28 and is of slightly larger diameter than the tool 23, such crest, however, extending through a less arc than that of the crest 26, and such tool is shown as provided with faces 29 also disposed upon the predetermined angle of the thread. The tool 25 is shown as having a crest 30 of less extent than the crest of the preceding tool, and this will give the finish to the bottom of the thread forming groove. Such tool is provided with side faces 31 corresponding to the angle of the completed thread. The shape of the crest 30 and of the faces 32 between the several tools are for giving the shape to the bottom of the groove and the apex of the thread approximately corresponding to the Briggs standard pipe thread. This form of thread has been arbitrarily selected for this illustration, and such thread is a standard. The inner tool 21 is in the present instance a member having a screw threaded exterior; it having the pitch of the contemplated thread but the faces of its convolutions are shown at a different angle, in the present instance at an angle of 50 degrees. It will be seen that the apex 35 of the working face of the inner member is slightly rounding, and that the faces 36 are disposed at an angle of about 50 degrees one to the other.

In bringing the tools together for operation the faces 32 will be disposed above the faces 35 in a radial line. As the metal is broken down or swaged into position by the first tool 23 the wall of the metal between the faces 27 and the apexes 35 will be pinched, the metal below the face 26 will be forced down and there being regions of support afforded the inner faces 31 of the wall of the tube at the apexes 32 and the portions of the faces 37 adjacent thereto the metal will be prevented from being displaced at these regions of support; but the translation or swaging in of the tube wall against these regions of support will cause a flowage outward for the upbuilding of the thread, and since it will enter the metal in excess of its ability to forge up the crest of the thread and swage in or taper the tube, the excess metal will flow downwardly toward the region devoid of support indicated by 40. The next tool 24 will by its face 28 continue the downward displacement of the metal, and the faces 29 will carry forward the operation of fashioning the thread faces. The displacement and forging will continue as above alluded to, and the next tool will by its face 30 complete the bottom of the thread forming groove and its faces 31 will finish the faces of the thread convolutions. The pressure exerting force in the directions indicated at 41 will have a tendency to pinch

out or squeeze out the metal, causing it to flow toward the region 40 for building up and reinforcing the tube wall to compensate for the tendency of the metal to flow in the direction of the arrow 42 for the upraising of the crest or apex of the thread. The tendency of the faces 26, 28 and 30 are to stretch out and draw the metal, attenuating the same, but the effect of the other faces in co-operation with the inner forming tool is to induce the flowage of other metal toward such region and build it up so that the displacement is compensated for. The lines 50, 51 are disposed at about an angle of 60 degrees to each other, and are the lines of the faces 29 and 31 which give the angle to the screw thread. The lines 52, 53 are the lines of the faces 36 of the inner forming tool, and it will be seen that the lines 50, 52 and 51, 53 are at an angle of about 5 degrees one to the other. It will thus be seen that the working faces diverge toward the open space 40 and pinch the metal toward such region devoid of support.

It is immaterial whether or not the apex of the thread is completely and thoroughly built up so long as the bottom of the thread forming groove is properly shaped, and has sufficient metal below it to give strength to the structure as a whole. In cutting a thread the metal is removed from a spirally disposed groove, and when forming pipe threads the taper, which is universally given the thread is produced bringing the dies gradually toward the axis of the tube, there is no appreciable swaging in of the wall of the tube and tapering it interiorly, the taper being produced entirely by cutting away the metal.

By reference to Fig. 2 it will be seen that the line 60 indicates the line of the outer face 38 of the portion of the tube 7 which has not been acted upon, and the line 61 indicates the bottom of the thread forming groove at about its last convolution, which it will be seen is at a considerable distance below the inner face 37 of the tube wall, and it will be seen that such threads are in accordance with the formula of the Griggs thread. Such threads could not have been cut upon metal tubing of the thickness illustrated in Fig. 2 since the height of the thread indicated between the lines 61 and 62 is about equal to the radial thickness of the tube wall and sufficient metal would not be left below the bottom of the thread forming groove to sustain even the action of the cutting dies in forming such thread, and considering the distance between the lines 60 and 61, showing the amount of reduction of the bottom of last convolution of the groove from the outer face of the tube wall, it will be seen that metal of at least the thickness indicated between the lines 60 and 63 would be necessary for use in a tube having cut threads of similar height and taper to those illustrated in Fig. 2. The taper given in present practice for pipe threads is about $\frac{3}{4}$ of an inch to the foot, and that is the taper that has been illustrated in Figs. 1 and 2. It will be seen that not only is the thread given a conical disposition; but the tube wall itself is also given a conical disposition.

This present improvement does not corrugate the walls of the tubing as such term corrugation generally implies when applied to a metal; although in the corrugation *per se* of a piece of sheet metal there is an amount of molecular reorganization at the crests of the bends, and the action of the corrugating tools doubtless will produce a certain amount of working of the metal; but

not the amount of forging-up of the metal as here contemplated, and a readjustment of the entire mass of metal. The metal at the summits of the corrugations is weakened by attenuation and by the crystallization due to the stretching of the metal in its bending. In applicant's method metal is built up on the portions which in corrugation are thus weakened. In practicing this present improvement, a portion of the tube wall is translated inwardly for giving the taper to the end of the tubing and then the metal in such translated portion is forged so that it is redistributed. It is forged or built up upon the outside for forming the thread and inwardly for forming a reinforce. The tube wall by its translation is given a conical formation and such tube wall is moved inwardly in excess of the conical surface described by the summit of the thread in its series of convolutions in the completed taper thread. The wall is translated into a cone more obtuse than is the finished product. The change in the angle is effected by raising the thread higher toward the smaller end of the threaded tube end than it is at the other or larger end thereof. If anything so built up can be considered as a corrugating of the metal then it will be seen that there is a forged-up crest upon the summit of each corrugation upon one side of the tube, and the summit of each corrugation upon the other side of the tube has reinforcing metal forged-up upon it. And after having so distinguished from corrugation it is believed that no confusion can exist. From the apex or crest radially inward solid metal is presented of greater thickness than the original thickness of the tube wall, and from the bottom of the thread forming tool radially inward solid metal is presented of at least the thickness of the original tube wall, and whereas in the corrugating of metal the metal upon the outer face of each crest of corrugation is somewhat stretched, with its incident thinning of the metal and the opening apart of the interstices between the molecules or grains of the metal, in the present instance the metal is pressed and compacted at similarly situated regions. Even assuming that in some instances the metal below the bottom of the thread forming groove might be thinner than the original tube wall thickness, yet owing to the forging and working treatment to which it is subjected it will not have been weakened by the operation; but on the contrary have been strengthened.

It will be noticed, more particularly in Fig. 1, that the convolutions of the thread at the left hand side have concave apexes, there being raised portions 65 at each side of the depressed central portion 66. This is due to the forging or working action of the faces of the tools, and as the thread proceeds convolution by convolution toward the right hand it will be seen that the groove becomes deeper and the thread becomes higher and the apex narrower and less concave until finally the thread is given its finished apex.

Although this present improvement may be practiced by the use of various instrumentalities, yet the device illustrated in Fig. 3 is particularly useful in this regard. This is illustrated as embodied in a device which may take the form of a tool, that is, such a device as may be carried from place to place by a workman in his kit of tools. The working portions are illustrated housed by a framing or casing member 70, having an interiorly screw threaded hub 71, and also

4
 5 having a screw threaded connection with a cap portion 72, which two portions together house the co-operative working parts. The cap portion is shown as provided with a number of openings 73, leaving intermediate arm-like portions 74, the screw threaded hub 75 is longitudinally slotted and the arms are resilient, such hub is shown as having a taper thread so that when a nut 760 is screwed up upon it it will press against a section of tubing 7 and clamp the same in position for treatment, it thereby constituting, as it were, a chuck. The inner and outer forming tools are carried by a tool carrier or head 76 having fast with it a screw threaded shaft 77 engaging with the screw threaded hub 71, and which shaft is shown as having fast upon it a head 78 having sockets for receiving a suitable bar for rotating the tool carrier. The inner forming tool 21 is shown as having a screw thread 79 upon it which is of the same pitch as the thread upon the shaft 77. In this illustration there is shown a structure which will have three sets of outer forming tools for co-operation with the inner forming tool in the production of a screw thread.

10 In the drawings Fig. 3 shows but two sets of tools, one such set having been omitted, due to breaking away parts of the device for showing its internal construction. Each of these is illustrated as comprising a body portion 80 which might be designated as a roller, and having upon it the tool members 23, 24 and 25. Upon the rotation of the shaft 77 the inner forming tool will be rotated upon its axis, and the various outer forming tools will be revolved about such axis, which will approximate the axis of the tube being worked upon. The tool carrier is shown as comprising a pair of plates 81 and 82, which are bored through for forming bearings for the spindles 83 upon which the forming tools are mounted, such spindles will be held in place by some suitable means.

30 Upon each spindle is mounted an eccentric member 84, that is, it is of a general cylindrical formation, and has an eccentrically disposed bore forming a working fit with the spindle, and is provided in the central portion with a flange 85. The respective forming tools are mounted on the eccentrics and on one side of the flanges with a working fit, and at the other side of each flange a sheave 86 will be mounted on each of the eccentrics. These sheaves and eccentrics are for co-operation with suitable cam faces for bringing the tools to their working position, and after they have been brought to such working position for gradually pressing them toward the center of the tube for producing the desired taper upon the screw threaded portion. It will be seen that the inner face of the casing 70 constitutes a cam of conical formation, it having an angular face 87 and an angular face 88 at a more acute angle to its axis. The face 87 is for engaging the sheaves 86 as they are moved axially during their revolution incident to the axial movement of the tool carrier head upon the rotation of its shaft 77. The engagement of the cam face 87 with the face 89 of the sheave will cause it to press upon the eccentric 82 which will squeeze the eccentric around so that the inner portion will be advanced in the direction of the arrow, which is the direction of rotation of the sheave by virtue of its engagement with the face 87, the head moving in the direction of the arrow upon it. This will bring the

thinner portion before referred to between the sheave and the spindle toward the outer side of the head, and will bring a thicker portion between the spindle and the portion of the sheave toward the center of the head, which will bring such thicker portion of the eccentric between the body portion of the roller which is in engagement with the work, and the spindle and press it into the work.

The threading operation will be commenced at a point inward of the end of the tube, and be advanced toward such end, the tools running off of the thread, the inner forming member screwing out of the groove 90, which has a spiral formation.

It will be observed that in employing an instrumentality such for instance as that illustrated in Fig. 3 there will be a concurrent action of several rolls upon various portions of the tube walls and each portion of the tube acted upon will be subjected to the consecutive action of each of the tools, for instance if there are nine tools employed each portion of the thread will be subjected to the action of the nine tools, which will produce a consecutive action and forming thereby producing a better finish and a more compact quality of metal, not only in the thread but in the forged-up metal at and below the bottom of the thread forming groove.

In the foregoing description it has been found convenient to employ the terms "up" and "down" particularly in the description of the operation as carried out and illustrated in Fig. 1. This as will be seen has reference to the position of the drawing upon the sheet, and is not intended as a limitation. Nor does applicant intend to limit himself to the raising of threads upon the outer perimeter of the tube and raising and spirally building up the inner side of the tube at the bottom of the thread groove, since it would be within the purview of this improvement to reverse the order and make couplings for instance having a forged up thread upon the inside and a forged-up groove-reinforce upon the outer side.

Having described my invention I claim:

1. That art of forming pipe threads which consists of applying inward pressure upon the outside of the pipe on a plurality of pairs of planes angularly disposed one to the other for forming the sides of a plurality of convolutions of the thread and a plurality of convolutions of the thread forming groove, and concurrently applying outward pressure to a region radially inward of the apex of each thread convolution being acted upon from the outside at two planes angularly disposed one to the other and leaving the region radially inward of the bottom of the thread forming groove without support to thereby induce flowage towards such region for thickening the tube wall below the bottom of said groove and continuing such treatment in a spiral path.

2. That improvement in the art of pipe thread formation which consists in applying pressure to the outside of the tube along a spiral path by a series of forming faces for shaping the respective side faces of a pair of adjacent convolutions of a screw thread, such forming faces being joined for shaping the bottom of the thread forming groove, and concurrently applying pressure to the inside of the tube along a spiral path disposed radially inward of the apex of the thread and at the same time permitting the unobstructed flowage of the metal inwardly below the bottom of said thread forming groove and thereby forming a reinforcing crest.

3. The art of pipe thread formation which consists in applying pressure to the outer side of a tube wall upon a plurality of planes angularly disposed to the radius of the tube and pressing a spiral groove in the said outer side of

5 the tube wall, and during such pressure upon the outer side of said tube wall applying pressure to the inner side of the same radially inward of the apex of the thread being formed and forming a spiral groove in the inner side of said wall, such grooves corrugating the tube wall, and by the co-operation of such pressures concurrently with such corrugation building up a crest upon the summits of the corrugations upon the outer and the inner sides of the tube, the crest upon the outer side forming the apex of

the thread and the crest upon the inner side forming a 10 reinforce inwardly of the bottom of the thread forming groove.

Signed at Nos. 9 to 15 Murray street, New York, N. Y., this 16th day of March, 1906.

CHARLES L. CUMMINGS.

Witnesses:

CHAS. LYON RUSSELL,
FRED J. DOLE.