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W. D. GROSS  
MACHINE FOR FORMING THREADS WITHIN A METALLIC  
TUBE BY SWAGING

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2 Sheets-Sheet 1

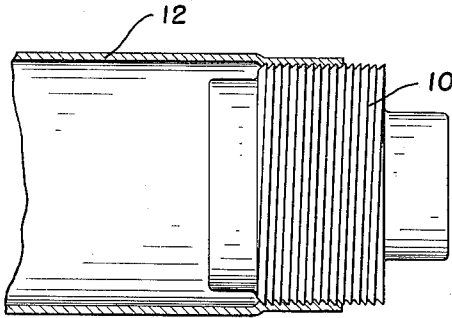


Fig. 2

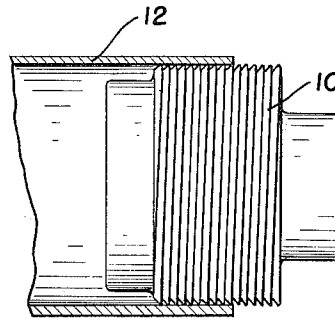


Fig. 1

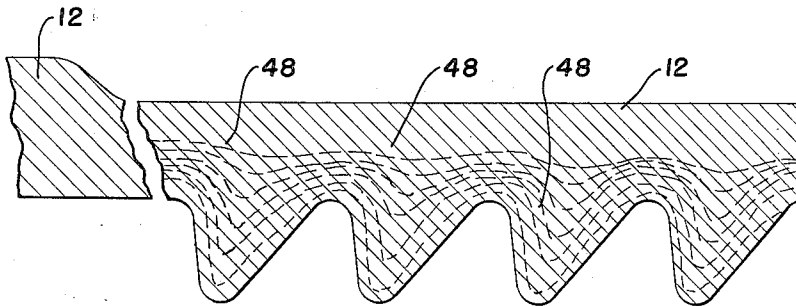


Fig. 3

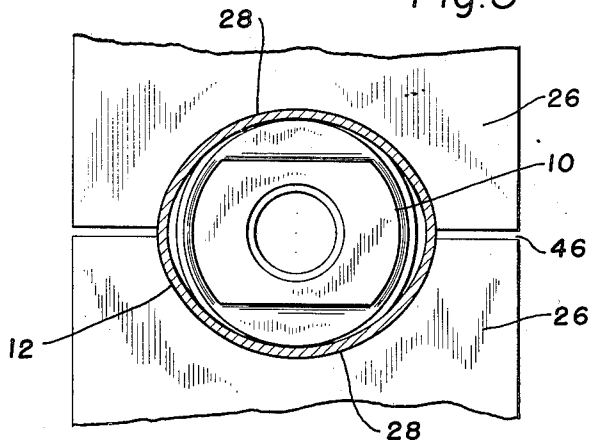


Fig. 6

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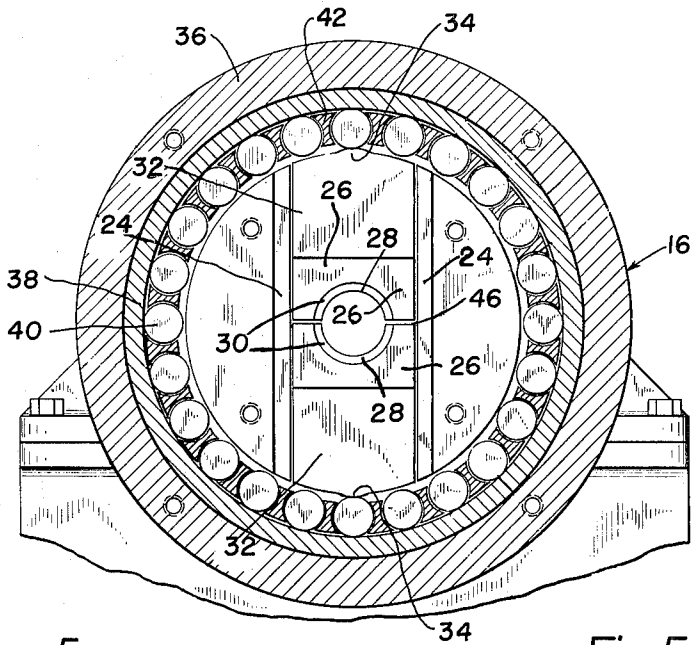


Fig. 5

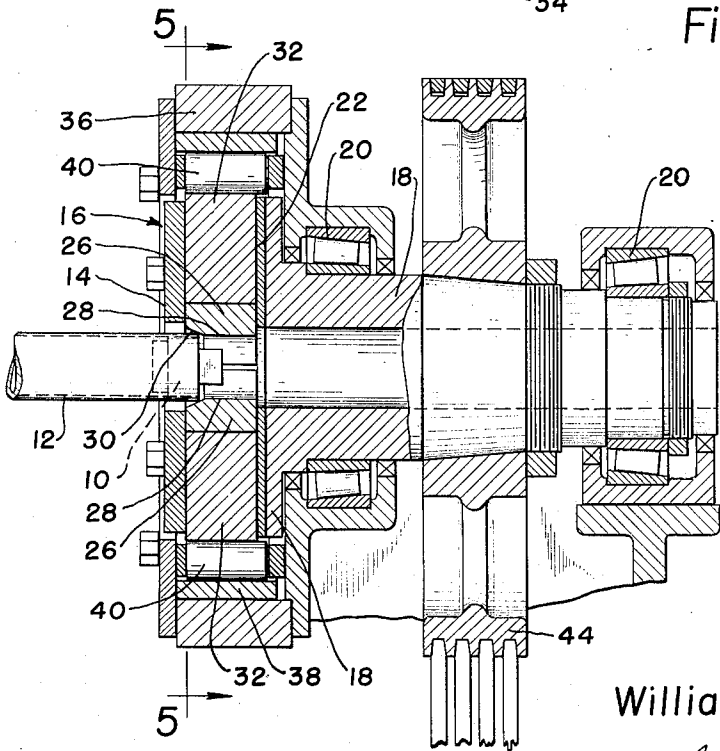


Fig. 4

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## MACHINE FOR FORMING THREADS WITHIN A METALLIC TUBE BY SWAGING

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2 Claims. (Cl. 10-153)

This invention relates to a process for forming threads in metallic tubing and the threaded tube product resulting from the process. More particularly, the process relates to the formation of threads on the inner surface of metallic tubing and the internally threaded product resulting from such operation. Without restriction thereto, the process is especially adapted to the formation of threads in a relatively thin-walled tube.

The formation of internal threads in a pipe, for example, of substantial wall thickness, may be accomplished by cutting, grinding, or swaging suitable threads thereon or therein, especially where the depth of the threads either is considerably less than the thickness of the pipe or the wall thickness between the external diameter of the pipe and the roots of the threads is adequate to furnish sufficient strength in the product. However, situations occur where it is desirable to provide internal threads, for example, in relatively thin-walled tubing, and when such situations arise, the formation of threads on the interior of such tubing by conventional practice is inadequate, primarily because the remaining wall thickness between the exterior of the tube and the roots of the thread does not provide adequate strength in the threaded areas of the tubing or there is inadequate wall thickness to permit threads of a desired height to be formed by such methods.

The present invention provides a process for forming threads particularly on the interior of relatively thin-walled tubing by a swaging operation which results in a reduction of the outer diameter of the tubing and thereby affords an increase in the wall thickness of the tubing in the swaged area, the resulting increase in the wall thickness providing metal which may be swaged into threads in such manner that the thickness of the tubing between the outer diameter thereof and the roots of the threads may either be equal to, greater than, or less than the initial thickness of the tubing, depending upon the requirements of the product as to wall strength, the depth and shape of the threads, and the hardness of the metallic tubing, these being examples of at least the major factors to be considered in utilizing the process comprising the present invention.

This process preferably is performed by using an externally threaded plug having a diameter less than that of the internal threads to be formed within the tubing, the degree or extent of reduction in diameter depending principally upon the hardness and elasticity of the material of the tube. Further, one of the factors which contributes to the effectiveness of the process comprises the utilization of external swaging dies which are elliptical in shape as distinguished from being a true arc of a circle, whereby the tubing, while being swaged relative to the threaded plug assumes an oval configuration. The primary advantage of this is the resulting ease with which the threaded plug may be removed from the product, there being no binding between the threaded plug and the internally threaded portion of the tubing as would result if the tubing with a threaded plug therein merely was forced

longitudinally through a drawing die, for example, of smaller internal diameter than the external diameter of the tube.

The process comprising the invention finds its greatest use primarily in metal tubing which is soft or at least only mildly hard such as for example, but without restriction thereto, soft steel, aluminum, brass, bronze and lead. It has been found that the process is highly useful relative to metal tubing having a hardness not substantially in excess of 225 Brinell. Under some circumstances, the shape of the thread will have a bearing upon the hardness and elasticity of the material upon which the process may be performed, due to the fact that the metal is flowed around the threads of the threaded plug during the performance of the process and while the outer diameter of the tubing is being decreased in a swaging machine.

One of the resulting advantages of the present invention is that, by a single operation, the process of the invention achieves what otherwise would require the successive steps of: upsetting the tubing by forging or swaging, for example; forming threads on the interior of the upset portion either by cutting, grinding or rolling; and then finishing the outer diameter to the required size and surface conditions. The latter are at least the minimum operations required to approach the results obtainable by the single operation comprising the present invention.

Other characteristics and advantages of the present invention over the practices presently used to form internal threads in tubing and pipe, and the desirable product resulting therefrom are set forth in the following specification and the details of such process and product likewise are described therein. The drawings attached to the application and comprising a part thereof illustrate the invention in an exemplary manner but without restricting the same to the specific showings therein.

In the drawings:

Fig. 1 is a fragmentary, vertical sectional view of relatively thin-walled tubing having a threaded plug inserted in one end thereof, this view showing this assembly prior to the commencement of the swaging operation.

Fig. 2 is a view similar to Fig. 1 but showing the same end of the tubing after the same has been constricted in outer diameter and swaged around the threaded plug for purposes of forming internal threads within the tubing.

Fig. 3 is a fragmentary, sectional view of the threaded end of a relatively thin-walled tube after threads have been swaged within the same, this view being on a much larger scale than Figs. 1 and 2 and the figure also being broken to foreshorten the same. This view also illustrates in an exemplary manner the grain lines of the metal in the swaged and threaded end of the tubing.

Fig. 4 shows a vertical, longitudinal sectional view of an exemplary two-die tube swaging machine suitable for purposes of performing the swaging portion of the process comprising the present invention.

Fig. 5 is a vertical, transverse sectional view of the swaging machine shown in Fig. 4, taken on the line 5-5 of Fig. 4.

Fig. 6 is an exemplary illustration, on a larger scale than Figs. 4 and 5, showing in exaggerated manner the oval configuration momentarily assumed by the tubing and the elliptical shape of the exterior swaging dies as they appear during one of the successive swaging impacts of the dies during the swaging operation.

For purposes of clarity in describing the process comprising the present invention and the product resulting therefrom, a specific example of tubing and exemplary dimensions have been selected for description hereinafter but it is to be understood that the invention is not to be restricted to these selected items inasmuch as a relatively wide variety of other dimensions and

tubes or tubing of other material may be used within the spirit of the invention.

In Figs. 1 and 2, an exemplary, relatively soft aluminum alloy tube having an outer diameter of two inches and a wall thickness of .065 inch has been selected for description and illustration. An externally threaded plug 10, formed from tool steel and hardened, the threads of which are the complement of the desired shape and pitch for the threads required in the product, is inserted within one end of tube 12. The external or major diameter of the selected threaded plug can be a few thousandths of an inch in excess of the inner diameter of the tube 12, whereby the plug is slightly forced into the tube, thus initially disposing the threaded plug 10 within the tube to a desired position.

The assembled threaded plug 10 and tube 12 then is introduced to the entrance end 14 of the exemplary two-die tube swaging machine 16. This machine comprises a spindle 18 rotatably supported between spaced anti-friction bearings 20, the outer end of said spindle being enlarged in diameter as shown at the left-hand end of Fig. 4. This enlarged end of the spindle has a transversely extending groove 22 defined by parallel guide plates 24. Positioned between the guide plates 24 within the groove 22 are a pair of similar swaging dies 26. Each of these dies have semi-elliptical or ovoid cavities 28 therein which comprise the swaging or work-engaging faces of the dies.

To facilitate the insertion of the assembled threaded plug 10 and tube 12 between the dies 26, the entrance ends 30 of said die cavities preferably are beveled as shown best in Fig. 4. Also, in the preferred construction, the dies 26 are engaged by block-like members comprising backers 32. Each of the backers 32 is provided on the outer ends thereof with a rounded projection 34, for purposes to be described. The head 36 of the swaging machine 16 is annular and is provided with an inner wear-ring 38 which is engaged in rolling contact by a series of hardened rolls 40 similar to the anti-friction members in a roller bearing. Said rolls are spaced evenly circumferentially and are maintained in properly spaced relationship by a roll rack 42.

During the operation of the swaging machine 16, the head 36 and inner wear-ring 38 are stationary, while the spindle 18 is rotated by any suitable means such as a pulley 44 driven by appropriate power means. The spindle 18 usually is revolved quite rapidly and, as an exemplary illustration, it will be assumed that the spindle is rotating at a speed of 250 R. P. M. In the specific illustration of Fig. 5, 24 rolls 40 are illustrated. Also, it will be noted that in the normal position of the dies 26, there is a slight space 46 between the opposed flat faces of the dies 26. Said space insures that the dies 26 will be reciprocated during the impacting function thereof which is induced by the engagement of the rounded projections 34 of the backers 32 sequentially with the series of rolls 40 as the spindle 18 revolves. The specific assumption of speed and illustrated mechanism described above delivers 6,000 impacts per minute by the dies 26 against the tube 12. Thus, it will be seen that highly effective and rapid swaging and reduction in diameter of the tube 12 will take place in the end portion thereof, resulting in the flowing of metal from the inner surface of the reduced portion of the tube into the cavities between the threads of threaded member 10 as shown in Fig. 2.

During the swaging operation, the tube 12 and plug 10, in general, are held against rotation but are fed gradually and longitudinally into the space defined by the die cavities 28. However, during the instant that the dies 26 are in impacting contact with the tube 12, said tube will move rotatably for that instant with the dies. However, there is no relative movement between

the threaded plug 10 and the tube 12 during such swaging operation.

In view of the semi-elliptical shape of the die cavity 28, the tube 12 momentarily will assume an elliptical or oval shape as illustrated in exaggerated manner in Fig. 6 of the drawings, during the swaging operation. Actually, for the exemplary diameter of the tube shown in the instant illustrations, the difference between the major and minor axes of the ellipse assumed by the tubing will be slight and of the order of only about ten or twelve thousandths of an inch in the preferred operation of the invention. Nevertheless, this difference is adequate to prevent binding between the plug 10 and tube 12 and also smooths out any unevenness or irregularities initially in the tube. Thus, any initial oval shape or otherwise in the tube, within reasonable limits, may be disregarded.

It will of course be understood that, due to the tube 12 being held stationary relative to the rotating spindle 18 and dies 26, and also due to the rapid impacts of the dies, the ovalizing of the tube progressively changes very rapidly and constantly, whereby no oval shape of any importance occurs in the finished product and the same is substantially cylindrical. The swaging continues until the tube and die have been inserted into die cavities 28 the required amount so as to produce a desired length of internally threaded area within the tube 12. The swaging then is discontinued and the tube and die are removed from the swaging machine. The threaded plug 10 then is removed from the threaded tube 12 by unscrewing the same. A finished, internally threaded tube 12 thus is produced which requires no appreciable finishing operations other than perhaps grinding the end of the tube to a desired length if such is critical.

To complete the description of the exemplary dimensions of the tube illustrated in the drawings, the outer diameter of the threaded portion of the tube 12 will have been reduced approximately .050 inch less than its original diameter of 2 inches. The wall thickness between the outer diameter of the threaded portion of the tube and the roots of the threads will be approximately .037 inch and the height of the threads will be approximately .041 inch. In this specific and exemplary illustration of the invention, it will be seen that the wall thickness in the threaded portion of the tube is still over half its original thickness and has threads of a height of approximately two-thirds the original wall thickness of the tube formed within the interior thereof.

Under ideal conditions, the process comprising the present invention is so performed that the amount of metal resulting from the decrease in outer diameter of the swaged and internally threaded portion of the tubing substantially will equal that required to form the threads on the interior of the tube. Under these conditions, substantially no elongation of the tube results and, consequently, no metal scrap is formed. Further, no additional finishing operations are required particularly if the threads on the threaded plug 10 are exactly complementary to the shape desired for the threads within the tube 12.

The invention also has a still further advantage comprising the fact that the flowing of the metal of the tube, resulting from the decrease in the diameter of the swaged portion thereof around the external threads of the threaded plug 10, results in a continuous grain structure being produced in the threads which, adjacent the thread surfaces, is parallel thereto, as illustrated in exemplary manner by dotted lines 48 in Fig. 3. Such grain structure results in the threads being far stronger than threads which are formed either by cutting or grinding, for example.

In performing the process comprising the present invention to form threads on the interior particularly of relatively thin-walled tubing, the diameter of the threaded plug 10 is less than the corresponding diameter of the

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threaded portion of the tube 12 but the difference in these diameters will depend primarily upon the hardness and elasticity of the material from which the tube is formed. For example, the softer the material, the closer the diameter of the threads within the tube may be to the diameter of the plug 10, and vice versa. Also, the ellipticity of the die cavities 28 will vary in accordance with the hardness of the material of the tube 12; tubes of harder material requiring more die ellipticity than softer material. Further, the process is such that, within reasonable limits, the pitch, profile, or depth of threads to be formed in the tube may be varied quite widely.

While the invention has been shown and illustrated in its preferred embodiment and has included certain details, it should be understood that the invention is not to be limited to the precise details herein illustrated and described since the same may be carried out in other ways falling within the scope of the invention as claimed.

I claim:

1. A machine for swaging threads on the interior of metallic tubing comprising in combination, a plug having external threads thereon complementary in shape and pitch to and slightly smaller in diameter than those to be formed on the interior of said tubing, said plug being insertable within one end of said tubing, a swaging head having an opening extending longitudinally therethrough to receive tubing to be threaded, a pair of dies carried by said head and supported thereby for radial reciprocation within a plane transverse to said longitudinal opening within said head and said axis, said dies having smooth concave ovoid surfaces on the opposing faces thereof complementary to each other and engageable with the exterior of said tubing respectively at opposite sides thereof, means to effect relative axial rotation between said head and tubing to be threaded, and means on said swaging head engageable with said dies during such relative rotation and operable to reciprocate said dies simul-

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taneously and radially against said tubing and swage the same against said threaded plug therein, whereby such swaging by said dies decreases the diameter of said tubing and effects an accretion which is dispersed into threads on the interior of said tubing conforming substantially with the pitch and depth of the threads of said plug, the ovality of said dies causing said tubing to become oval momentarily and progressively around the circumference thereof during engagement of said tubing with said plug to prevent freezing of said tubing to said plug and the smaller diameter of the threads of said plug permitting ready unthreading thereof from said tubing when the threading thereof has been completed.

2. The thread swaging machine set forth in claim 1 further characterized by the threads on said plug in cross-section having angularly related surfaces to form crested threads, whereby the swaging of tubing against said threads on said plug causes the normally longitudinally extending grain thereof adjacent the inner surface of the tubing to be rearranged so as to be substantially parallel to said surfaces of the threads on said plug at least adjacent the outer surfaces of the threads formed on said tubing.

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