United States Patent

Jackson

[15] **3,678,727**

[45] **July 25, 1972**

[54] **STRETCH-DRAW TUBING PROCESS**

[72] Inventor: **Robert G. Jackson**, 11020 Dunklin Drive, Apt. 312, St. Louis, Mo. 63119

[22] Filed: **Aug. 27, 1970**

[21] Appl. No.: **67,476**

[52] **U.S. Cl.** **72/367**, 72/378

[51] **Int. Cl.** **B21c 37/06**

[58] **Field of Search**....................72/274, 283, 367, 368, 378

[56] **References Cited**

UNITED STATES PATENTS

3,469,425 9/1969 Spurr et al. 72/378

Primary Examiner—Lowell A. Larson
Attorney—Jackson, Jackson & Chovanes

[57] **ABSTRACT**

Metallic tubing is drawn under tri-axial stress. A tube which has the capability of cold work is used as a starting material. The tube is stretched longitudinally under cold working conditions without restraint against reduction in diameter and in cross section into the plastic range but below the point of necking to reduce its diameter. Then the tube is drawn with tools which subject it to force inwardly on two axes at right angles to the longitudinal axis and at right angles to one another under cold working conditions into the plastic range. The cold worked condition of the tube is retained during the stretching and drawing.

5 Claims, 25 Drawing Figures

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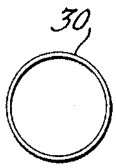

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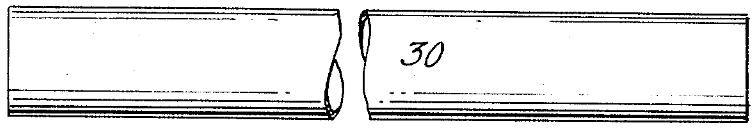
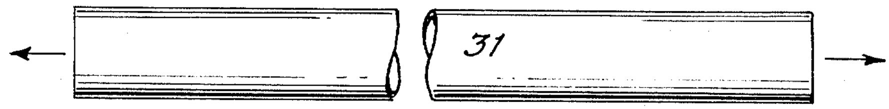


Fig. 1.



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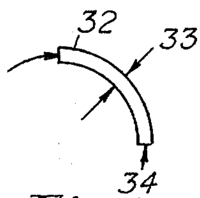

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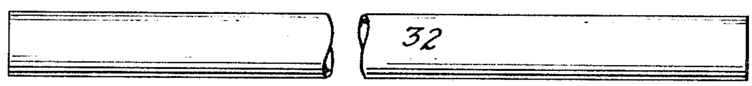

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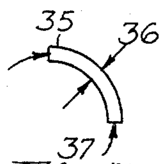

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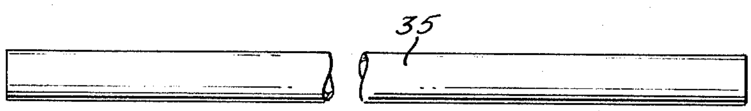

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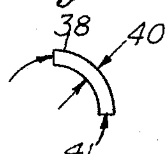

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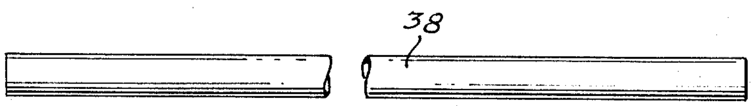

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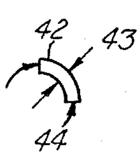

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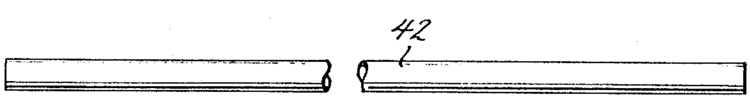

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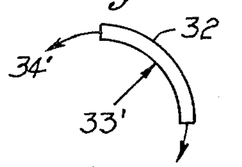
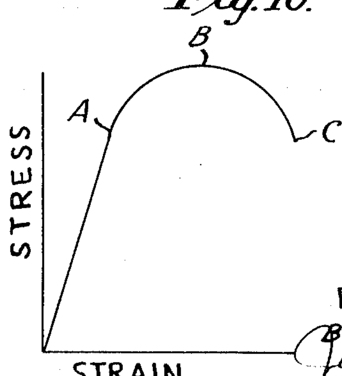


Fig. 11a

Fig. 12.



INVENTOR.
ROBERT G. JACKSON
BY Jackson, Jackson & Chovanes
ATTORNEYS.

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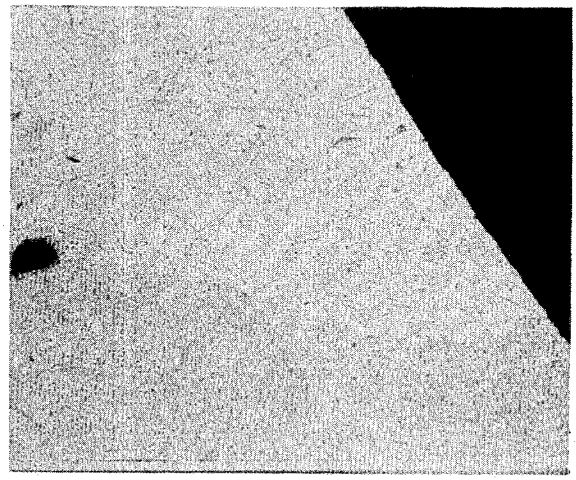


Fig. 13.

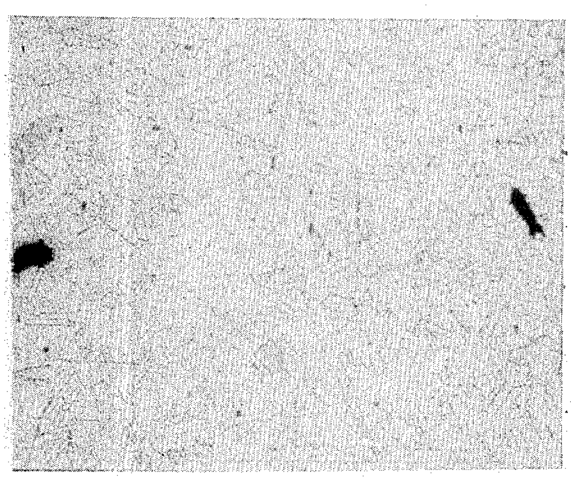
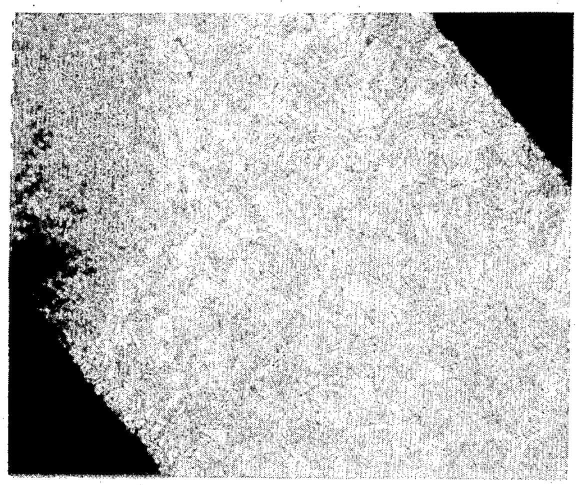


Fig. 14.

ROBERT G. JACKSON
Inventor

By Jackson, Jackson & Chovanes
Attorney



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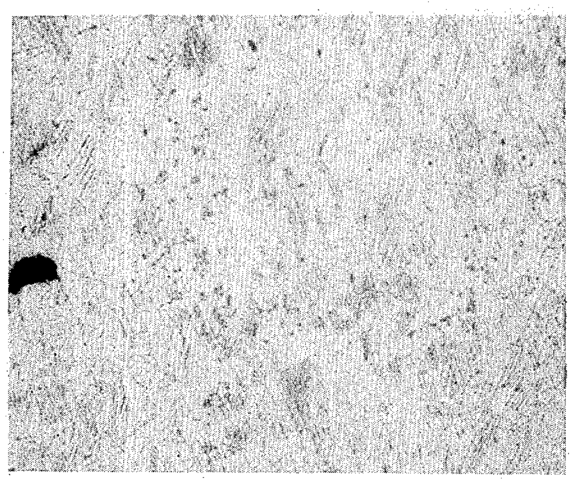
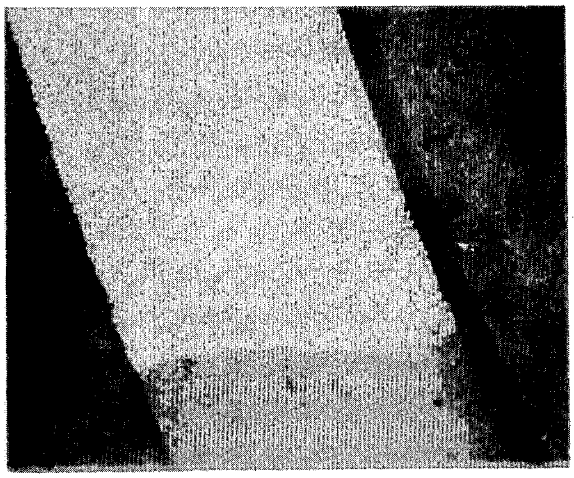


Fig. 16.

ROBERT G. JACKSON
Inventor

By Jackson, Jackson + Chovanes
Attorney



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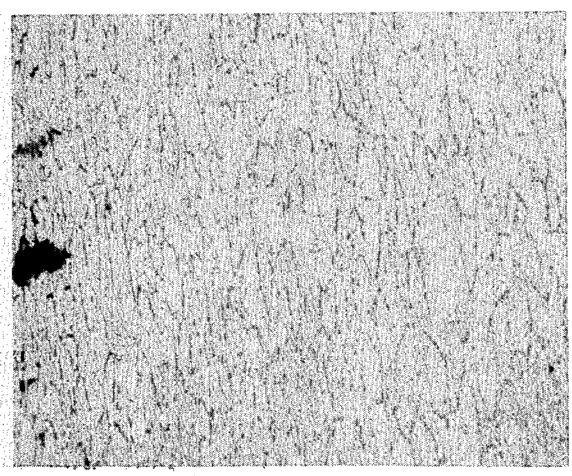
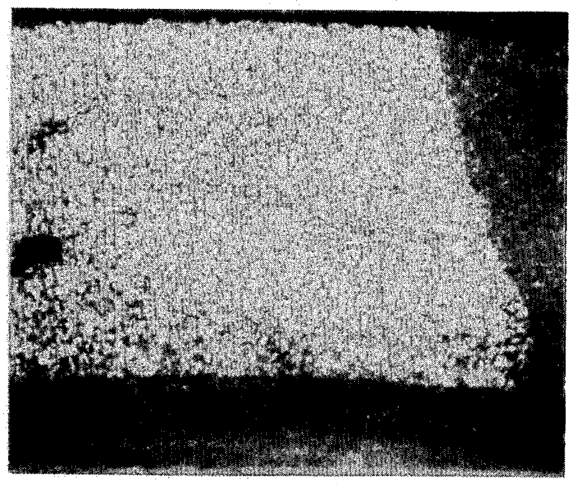


Fig. 18.

ROBERT G. JACKSON
Inventor

By Jackson, Jackson & Chovanes
Attorney



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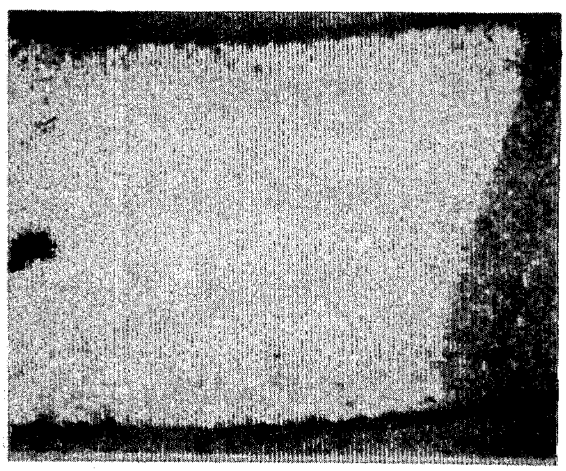

Fig. 20.

ROBERT G. JACKSON
Inventor

By Jackson, Jackson & Chovanes
Attorney

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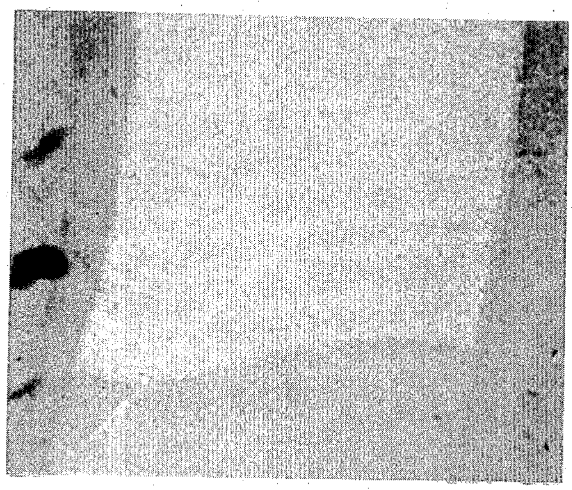

Fig. 21.

ROBERT G. JACKSON
Inventor

By Jackson, Jackson & Chovanes
Attorney

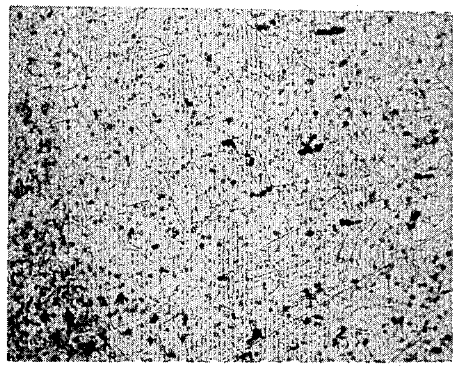

FIG. 22

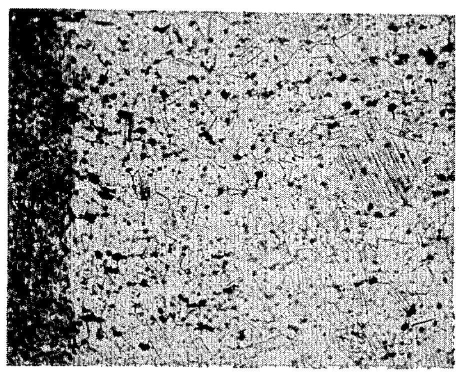

FIG. 23

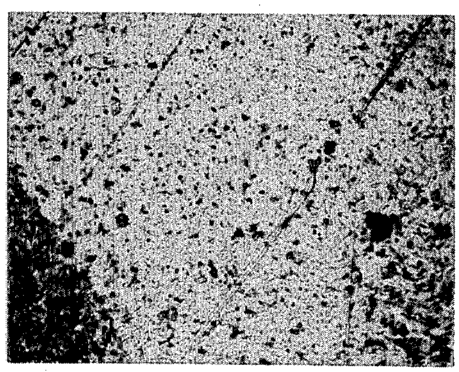

FIG. 24

ROBERT G. JACKSON
Inventor

By Jackson, Jackson & Chovanes
Attorney

STRETCH-DRAW TUBING PROCESS

DISCLOSURE OF INVENTION

The invention relates to a process of making metal tubes or pipes of any cold workable metal by stretch-drawing.

A purpose of the invention is to reduce the wall thickness and diameter of a tube by tri-axial deformation, one axis being the longitudinal axis and the other two axes being at right angles to the longitudinal axis and at right angles to one another.

A further purpose is to start with a tube capable of cold work and preferably annealed, to stretch the tube longitudinally under cold working conditions without restraint against reduction in diameter and in cross section into the plastic range but below the point of necking to reduce the tube cross section, and then to draw the tube with tools which subject it to force inwardly on two axes at right angles to the longitudinal axis and at right angles to one another under cold working conditions into the plastic range, the tube retaining its condition of cold work during the stretching and drawing.

A further purpose is to perform the two axes drawing on the tube with tools according to the process of sinking, plug drawing, core drawing, rod drawing, taper drawing, rock-rite drawing, or otherwise.

Further purposes appear in the specification and claims.

In the drawings I have chosen to illustrate the invention diagrammatically, the drawings being selected with respect to convenience in illustration and generality of description.

FIG. 1 is a broken side elevation of a metallic tube which may comprise the raw material of the invention.

FIG. 2 is an end elevation of the tube of FIG. 1.

FIG. 3 is a broken side elevation of the tube subjected to uniform stretching longitudinally, showing the result of the stretching in reducing the cross-section or diameter and wall.

FIG. 4 is a broken side elevation of a tube after the first step of compression drawing, in this case bar drawing, illustrating the reduction in cross-section where both the diameter and wall thickness are reduced.

FIG. 5 is an end elevation of a fragment of the tube of FIG. 4 to enlarged scale showing one set of arrows or axis applying radial pressure to the tube wall to reduce its thickness and another set of arrows or axis applying hoop stress in the tube wall at right angles to the radial axis.

FIG. 6 is a broken side elevation of the tube of FIGS. 4 and 5 which has been subjected to a first sinking operation, according to the invention.

FIG. 7 is an enlarged fragmentary end elevation of the tube of FIG. 6, showing the first sinking. The sinking tools are suggested by one set of arrows or axis applying stress radial of the tube wall, and another set of arrows or axis applying stress at right angles to said radial axis, both of the axes of stress being at right angles to the longitudinal stress.

FIG. 8 is a broken side elevation of the result of the second sinking operation applied to the tube of FIGS. 6 and 7.

FIG. 9 is an enlarged fragmentary end elevation of the tube of FIG. 8 after the second sink, one set of arrows or axis being radial and the other set of arrows or axis being at right angles to said radial axis, both of the axes being at right angles to the longitudinal stress.

FIG. 10 is a broken side elevation of the result of the third sinking operation on the tube of FIGS. 8 and 9.

FIG. 11 is an enlarged fragmentary end elevation of the tube of FIG. 10 showing two sets of arrows to suggest the action of the third set of sinking tools, one set of arrows showing stress in the radial direction and the other set of arrows showing stress at right angles to the radial direction, both axes of stress being at right angles to the longitudinal direction.

FIG. 11*a* is a fragmentary enlarged end elevation of a tube which is undergoing drawing according to the second step of Example 5, one arrow being in the radial direction and the other set of arrows in tension at right angles to the radial direction, both of the axes of stress being at right angles to the longitudinal direction.

FIG. 12 is a stress-strain curve useful in explaining the invention.

FIGS. 13 to 21 are photomicrographs of the tubing at various steps in the process, examined at 100 diameters and electrolytically etched with oxalic acid.

All of the specimens are of type 304 or 18 percent chromium and 8 percent nickel stainless steel of commercial grade.

FIG. 13 is a transverse section of the raw material of FIG. 1.

FIG. 14 is a longitudinal section of the raw material of FIG. 1. FIG. 15 is a transverse section of the tube of FIG. 3 after undergoing uniform stretching.

FIG. 16 is a longitudinal section of the tube of FIG. 3.

FIG. 17 is a transverse section of the tube of FIG. 4 after the bar drawing pass.

FIG. 18 is a longitudinal section of the bar drawn tube of FIG. 4.

FIG. 19 is a transverse section of the tube of FIG. 6 after undergoing the first sinking.

FIG. 20 is a transverse section of the tube of FIG. 8 after the second sinking.

FIG. 21 is a transverse section of the tube of FIG. 10 after the third sinking.

FIGS. 22 to 24 are photomicrographs relating to an experiment on stainless steel type 304 tubing explained in Example 4. The tubing was examined transversely at 200 diameters and electrolytically etched with oxalic acid.

FIG. 22 was the result of stretching annealed tubing 7 percent and sinking it.

FIG. 23 was the result of stretching annealed tubing 15 percent and then sinking it.

FIG. 24 was the result of sinking annealed tubing.

In reducing tubes, stretching has been used, but without recognition of the importance of having the tube stretched as an integral part of a cycle of tri-axial straining, and without recognition of the importance of allowing the tube to reduce in diameter during stretching and to retain the effect of cold work in a subsequent operation of drawing. Inscho U.S. Pat. No. 2,051,948 stretches metallic tubes longitudinally, but heats them to recrystallization and also prevents reduction in diameter by using an interior mandrel. Tanomura U.S. Pat. No. 1,415,415 stretches a tube but prevents it from reducing in diameter by a fluid content inside.

In the present invention, a tube is stretched and reduced in diameter and cross section only as one step of a process of triaxial stretch-drawing, obtained from stretching, with the tube retaining its cold work from stretching while it is undergoing drawing.

The invention is operative on all ductile metals including those which crystallize on the face centered cubic system, body centered cubic system, hexagonical system and tetragonal system. Thus, it is applicable to iron and its alloys, copper and its alloys, aluminum and its alloys, zirconium and its alloys, titanium and its alloys, nickel and its alloys, cobalt and its alloys, silver and its alloys, gold and its alloys, platinum and its alloys, and many other metals and alloy systems too numerous to mention.

Raw Material

The raw material must have a capability of further cold work, and be in the form of a tube or tube blank. In many cases the raw material will be fully annealed before stretching, but in other cases it will have some heat treatment which does not fully recrystallize. Thus, it may be partially annealed, stress relieved or have an alloy solution heat treatment before stretching. If the previous drawing of the tube blank leaves it capable of undergoing further cold work, it may be used without a softening heat treatment.

Stretching

The stretching is a uniform longitudinal pulling operation which in its simplest form may be performed with a tensile testing machine or any apparatus capable of gripping the tube blank at the ends and producing a uniform elongation with capability of reduction in cross section (diameter and wall thickness). Thus, a mandrel drawing operation will not suffice.

The conditions under which the stretching is carried out must be cold working conditions and if any heat is present, it must not be sufficient to cause recrystallization.

By reference to FIG. 12, it will be seen what is accomplished by the stretching. In a typical ideal stress-strain curve the point A is the yield strength at 0.2 percent offset. Between the point of origin and the point A the elongation is elastic and for practical purposes the working is within the proportional limit. Between the point A and B permanent deformation takes place. Point B is the point of maximum stress which the metal can withstand under a uni-axial tensile test. Between points A and B the metal undergoes uniform strain throughout the length and cross section under test and in this range the metal is plastically uni-axially deformed. The effect of the elongation in this range is to reduce the diameter of the tube undergoing stretching and to reduce the wall thickness. Point C is the failure or fracture point. Between points B and C the metal undergoes necking, and the deformation takes place in a localized area. It is not proper to elongate to this extent.

The effect of the stretching is to produce cold work and it is important to preserve partially or wholly the effect of that cold work in the subsequent drawing with tools.

In most cases the stretching will not extend all the way to the point B, but will extend over a portion of the curve AB. In many metals about 2 to 5 percent elongation is sufficient in the stretching.

Drawing with Tools

The work is removed from the stretching, or permissibly the tube drawing is performed in the same machine. The tube drawing applies a force inwardly to the tube on two transverse axes at right angles to the longitudinal axis of the stretching and at right angles to one another. In effect it subjects the tube to compressive plastic deformation.

In many cases the drawing with tools is accomplished in several different operations, and they may be commercial tube reducing operations such as sinking, plug drawing, core drawing, rod drawing, taper drawing, rock-rite drawing or otherwise. Once again they must be carried out under cold working conditions, that is, below the recrystallization temperature. If any heat treatment is used after the stretching or between the cold drawing operations, it should not be sufficient to fully recrystallize as the effect of the previous cold work would then be lost.

Accordingly, the tube is subjected to tri-axial stress being stretched in the longitudinal direction by the stretching and in the two transverse directions by the tube drawing.

Tri-axial forming of tubing produces a product which is mechanically stronger than uni-axial or bi-axial drawing. Tri-axial forming permits more cold deformation than uni-axial or bi-axial forming. Also the crystallographic effect on cold worked metals is less with tri-axial than with uni-axial or bi-axial forming. All of these advantages of tri-axial forming and more are obtained by the stretch-draw process on tubing. Some of these advantages will be illustrated in the examples presented herein.

Subsequent Operations

In some cases, after longitudinally stretching and drawing with tools, the next step will be another cycle of stretching and then drawing with tools.

In some cases the product of the stretch-drawing may be heat treated and then subjected to a further drawing operation which may be stretch-drawing.

Likewise, in some cases the product of stretch-drawing may be heat treated and then marketed. In other cases the stretch-drawn product will be marketed without heat treatment.

EXAMPLE 1

Example 1 will be understood best by reference to FIGS. 1 to 11 and 13 to 21.

This is a specific illustration of application of stretch-drawing to austenitic stainless steel type 304 18 percent chromium and 8 percent nickel.

The raw material in this case is a welded tube which has been reduced by rod drawing to a tube blank 30, which has then been fully annealed. The tube blank 30 is then gripped as by grips at the ends and stretched according to FIG. 3 to form the stretched tube 31. The arrows 32 suggest the elongation by grips. The results of elongation in this case is of the order of 25 percent reduction in tube cross-section and is in the range AB and not beyond the point of necking. The operation is at ambient temperature in this case, and the metal does not become hot enough to recrystallize. There is no internal restraint on the tube, and therefore as shown it is able to reduce its diameter uniformly and reduce its wall thickness uniformly. After the stretching, the tube is subjected to drawing with tools as shown in FIGS. 3 to 11.

FIG. 4 shows the tube 32 after the bar drawing and FIG. 5 by arrows 33 suggests the action of the tools in compression reducing the tube on one transverse axis while arrows 34 suggest the reduction of the tube on another transverse axis at right angles to the axis 33.

FIGS. 6 and 7 show the tube 35 after the first sinking operation. The effect of the sinking operation in compressibly reducing the tube is suggested by arrows 36 which show one transverse axis and by arrows 37 which show the other transverse axis at right angles to axis 36.

FIGS. 8 and 9 show the tube 38 after the second sinking operation. Arrows 40 suggest the compressible reduction on one transverse axis and arrows 41 suggest the reduction on another transverse axis at right angles to axis 40.

FIG. 10 shows the tube 42 after the third sinking operation. Arrows 43 in FIG. 11 suggest the action of the tools in reducing the tube by compression on one transverse axis and arrows 44 suggest the action of compressing the tube on a transverse axis to right angles to the axis 43.

No heat treatment was applied to the tube subsequent to the stretching and through this sequence of bar drawing and sinking and so the properties were built-up by cold work to a tensile strength of more than 200,000 psi. The total tri-axial cold work resulted in about an 80 percent reduction in tube cross-sectional area.

FIG. 13 shows a transverse photomicrograph of the blank 30, and FIG. 14 is the longitudinal section. The grain size is ASTM 6.

The results of the stretch elongation of tube 31 is shown in transverse section in FIG. 15 and in longitudinal section in FIG. 16. Severe deformation is indicated along the slip planes. The grain size is ASTM 6.

FIG. 17 shows the cross section of the tube 32 after the bar pass, and FIG. 18 shows the longitudinal section after the bar pass.

The grain size in cross section is ASTM 7, and the grain size in longitudinal section is ASTM 7. The grains are elongated in the longitudinal specimen. FIG. 19 shows a photomicrograph of the tube 35 after the first sink pass. The grain size is ASTM 8. FIG. 20 shows a photomicrograph of tube 38 after the second sink pass. The grain size is ASTM 9.5.

FIG. 21 shows the photomicrograph tube 42 after the third sink pass. The grain size is ASTM 10.

Table 1 shows the mechanical properties.

TABLE 1

Mechanical Properties

	Initial Tube	After Stretch	After Bar Draw	After 1st Sink	After 3rd Sink
Yield					

Strength psi 0.2% Offset	46,900	130,500	163,000	172,200	191,600
Tensile Strength psi	96,400	142,900	188,200	198,000	227,000
Elongation % in 2 inch.	55	20	8	4	4
Rockwell Hardness	B72	C22	C44	C46	C48

Experience indicates the reductions accomplished by stretching, bar drawing and three sinkings, without failure, and without intermediate heat treatment, were more severe than could ordinarily have been performed by conventional methods without intermediate heat treatment.

An interesting effect is that the stretch tube **31** has a matte surface which tends to hold lubricant on the surface of the tube during the bar drawing. The other tubes have a shiny surface.

EXAMPLE 2

Example **2** demonstrates in a zirconium alloy that the hardening produced by stretching serves to produce a more drawable material with less tendency to gall or pick up on the tools than other drawing operations. It is possible by stretch-drawing to produce much more severe draws without failure of the work than would be possible in drawing soft zirconium alloy.

The raw material is welded tube lengths of Zircaloy **2** which has the following analysis:

Tin	1.4%
Iron	0.13%
Chromium	0.11%
Nickel	0.06%
Zirconium	remainder

The raw material is a nuclear circular canning tube having the following properties:

Size	.567″ × .038″ wall
Condition	The raw material was annealed at 914°F. This is not a full anneal since crystallization takes place at 1250°F. However, it permits the tube to undergo subsequent cold work with a significantly uniform stress pattern.
Mechanical Properties	70,000 psi yield strength with 0.2% set 90,000 psi ultimate tensile strength 36% elongation in 2″

Three tubes 36 inches long were used for the test. All tubes behaved the same, and the data presented are for the third tube.

The tubes were engaged in the grip of a long throat tensile machine and stretched without any lateral restraint. The tubes could be stretched uniformly to approximately 14 percent but in order not to produce any problem regarding the ultimate tensile strength or to generate any necking the stretching was stopped at 11 percent. Each tube was measured at two inch intervals before and after stretching over the original middle 24 inches of the tube. The data were as follows:

Location	Percent Elongation in 2″	After Stretch Diameter Max.	Min.	Average	Ovality
1	10.9	.5370″	.5365″	.5367″	.0005″
2	10.9	.5325	.5325	.5325	.0000
3	11.0	.5315	.5315	.5315	.0000
4	11.1	.5285	.5285	.5285	.0000
5	11.3	.5295	.5295	.5295	.0000
6	11.3	.5225	.5220	.5222	.0005
7	11.4	.5210	.5210	.5210	.0000
8	11.3	.5210	.5200	.5205	.0005
9	11.4	.5190	.5180	.5185	.0010
10	11.3	.5200	.5195	.5197	.0005
11	11.2	.5270	.5270	.5270	.0000
12	11.0	.5310	.5310	.5310	.0000

The diameter was 0.567 inch before stretching with ovality of 0.0010 inch.

The tube was stretched to a load of 90,500 psi on the original tube cross section or 97,200 psi on the cross section of the tube as stretched.

After stretching, the tubes were drawn by conventional methods without any intermediate heat treatment.

The maximum draw on fully annealed Zircaloy 2 tubing in conventional practice is 30–35 percent of the cross sectional area which must be followed by an anneal. Also, the tube must be coated in normal practice with an ultra high plastic lubricant to prevent galling and tearing. The specimens of the invention were drawn 32 percent of the cross sectional area by standard rod drawing without special lubricant. The drawn surface was better than the usual surface on such tubing. The tubing was then rod drawn for an additional 24 percent and sunk for an additional 17 percent reduction in cross section area. The total drawn tube reduction in cross section area was 62 percent of the original area. This was done without special lubricant and without any intermediate heat treatment.

The operators performing the stretching and drawing operations were familiar with drawing Zircaloy 2 by commercial methods, but they did not know the composition of the tubes under test. When asked, they stated that the tubes under test drew much easier than Zircaloy 2 as they knew it. They also stated that the complete drawing schedule could never have been performed with Zircaloy 2 regardless of what lubricant was used or what technique was used. These operators also did not know that the blank which was their starting material had already had 11 percent reduction, or that it was not in its softened condition when they received it. A full anneal of the starting material would permit more stretch in the tube before drawing. This would indicate that Zircaloy 2 could be drawn further by using the tri-axial stress method of the present invention. The operators also were of the opinion that they could have drawn the test pieces further without damage.

The final tubes were inspected visually and found to be acceptable. A dye penetrant inspection was also performed, and the tubes were found to be of high quality. The following Table 2 analyzes the results obtained in the various steps:

Deformation	Size Resulting Inches	Increment Reduction of Area in %	Total Reduction in Area % of 2 In.
Starting Material	.567 OD × .038 wall	0	0
Uni-axial Stretch	.522 OD × .0365 wall	11	11
1st Bi-axial Rod Draw	.463 OD × .0280 wall	32	40
2nd Bi-axial Rod Draw	.394 OD × .0250 wall	24	54
Bi-axial Sink Draw	.356 OD × .0238 wall	17	62

EXAMPLE 3

Solution heat treatment alloys such as aluminum alloys will respond better to subsequent aging or resolution and aging due to more uniform dispersion of elements by tri-axial forming.

Aluminum alloy **6061** has the following analysis:

Silicon	0.40–0.80%
Iron	0.70% max.
Copper	0.15 to 0.40%
Manganese	0.15% max.
Magnesium	0.8 to 1.2%
Chromium	0.15 to 0.35%
Zinc	0.25% max.
Titanium	0.50% max.
Other	0.05% each and 0.15% total
Aluminum	Balance

This alloy is solution heat treated and then stretch-drawn after which it is aged. The tri-axial deformation also produces a three dimensionally more uniform metal lattice distortion which responds more uniformly and efficiently in the solution and subsequent coherent precipitation. The more uniform dispersion of age hardening particles is evident in superior properties.

EXAMPLE 4

In Example 4 type 304 stainless steel tubing is stretch-drawn, less than the maximum amount in order to preserve ductility while improving strength by cold work.

The purpose is to produce a stretch-drawn tube with properties superior to existing tubing. The commercial application is especially in tubing for hydrolyics and for a fast breeder reactor in which work-hardened tubing 304 stainless steel has applications in heat exchangers and condensers.

All of the tubes were produced from the same heat of type 304 stainless steel. All sinking was done with the same bench, lubricant, die and operator starting with two blanks of previously welded, drawn, and annealed tubing 16 feet in length before stretching. Table 3 gives pertinent information concerned with the operation.

TABLE 3.—304 STAINLESS STEEL TUBING MECHANICAL PROPERTIES

	Tube A, start raw material, inches	Tube B, inches		Tube C, inches		Tube D, sink without stretching, inches
		8% stretch	Plus sink	12% stretch	Plus sink	
Finish size	[1] 0.376	0.364	0.313	0.358	0.313	0.313
	[2] 0.0360	0.0340	0.0350	0.0335	0.0345	0.0371
Yield strength, p.s.i	44,270	71,225	121,710	82,100	130,400	99,100
Tensile strength, p.s.i	96,354	102,564	133,223	102,900	137,200	130,000
Percent elongation (2 inches)	56	47	19	40	20	28
Percent reduction in area	59	55	49	55	47	49
Rockwell hardness	B-76	B-83	C-35	B-88	C-35	C-45

[1] O.D.
[2] Wall.

The results in the Table show that there was a significant improvement in yield strength by tubes B and C as compared with Tube D which is the control and also current practice. The percentage reduction in area has been maintained at a high level. The stretch-drawn tube is ten full points in hardness lower than the straight sunk tube.

The microstructure of similar tubes shows that the stretch-drawn tubes have less evidence of residual cold work. Thus, tube B of FIG. 22 and tube C of FIG. 23 have less evidence of residual cold work than the control of FIG. 24.

The appearance of the outside and inside of the stretch-drawn samples was brighter and smoother than that of the straight sunk sample.

The stretch-drawn tubes had a greater uniformity of tube size of the entire 16 foot length.

A similar series of experiments performed on copper base alloys, zirconium base alloys, other stainless steels and nickel alloys is planned to prove that similar results are obtained in other alloy systems. These alloys are recommended for tubing in desalination equipment.

EXAMPLE 5

A further application of stretch drawing is to perform the two axes drawing subsequent to the elongation by expanding the tube diameter with tools according to the process of internal diameter expanding with the mandrel, a plug or otherwise. This procedure is tri-axial the same as that obtained from stretch followed by inward force drawing except that the direction of the inward forces is reversed. This process is suggested by FIG. 11*a*, where arrow 33′ is radial and arrows 34′ indicate hoop stress in tension, rather than any compression as in other forms. This process has the advantage of working tubes with large outside diameter and light walls in which stretching is performed first and is an easy operation, but inward two axes drawing is a difficult operation due to wrinkling of the wall, tearing, and the like. For an outside diameter of two inches, type 304 stainless steel tubing with a wall thickness of 0.0050 inch, the wall can be stretched and then an internal plug expanded to bring the outside diameter to two inches again, with a net reduction in wall thickness to 0.0040 inch. Note that this wall reduction can be accomplished without touching the tube outside diameter.

It will be evident that when it is indicated that the tension stretching of the tube is a separate step applied first and the compression or tension in the radial direction plus the compressive hoop stress or the compression and tension in hoop stress plus the compressive radial stress are separate steps, it is intended to indicate that after the stretching the tension is relieved before the subsequent operation is performed.

In view of my invention and disclosure, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the process shown, and I therefore claim all such insofar as they fall within the reasonable spirit and scope of my claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The process of drawing metallic tubing, starting with metallic tubing capable of undergoing cold work, which comprises stretching the tubing longitudinally under cold working conditions without restraint against reduction in diameter into the plastic range but below the point of necking to reduce the diameter and wall, and then after relieving the tension drawing the tubing with tools which subject it to force on two axes at right angles to the longitudinal axis and at right angles to one another under cold working conditions into the plastic range, the cold worked condition of the tubing being retained between the operations.

2. The process of claim 1, in which the drawing of the tubing with tools is accomplished by compression of the tube wall in the radial direction, and compressive hoop stress.

3. The process of claim 1, in which the drawing of the tubing with tools is accomplished by tension of the tube wall in the radial direction, and compressive hoop stress.

4. The process of claim 1, in which the drawing of the tubing with tools is accomplished by compression of the tube wall in the hoop stress direction and compressive radial stress.

5. The process of claim 1, in which the drawing of the tubing with tools is accomplished by tension of the tube wall in the hoop stress direction and compressive radial stress.

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