

Oct. 7, 1947.

A. J. SNIVELY
METHOD OF TUBE DRAWING
Filed March 27, 1944

2,428,474

3 Sheets-Sheet 1

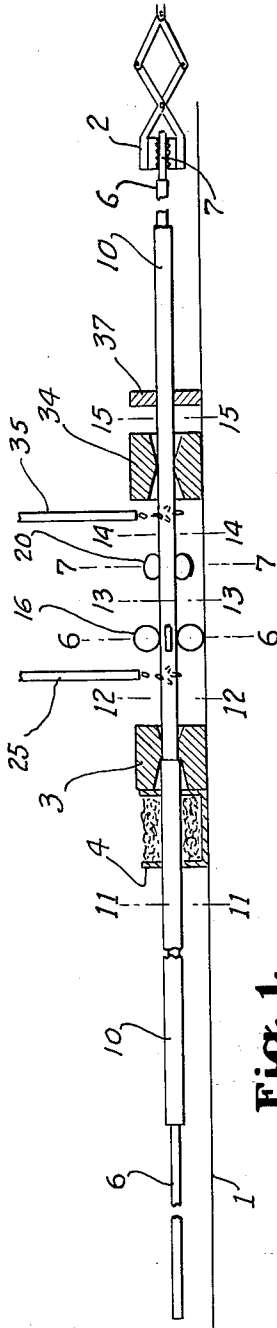


Fig. 1.



Fig. 2.

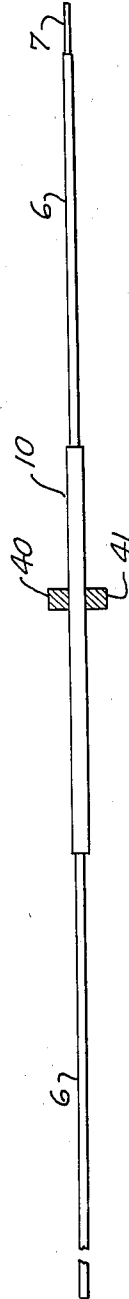


Fig. 3.



Fig. 4.

INVENTOR
Andrew J. Snively

BY
Barnes, Kinsella, Laughlin & Laisch
ATTORNEYS

Oct. 7, 1947.

A. J. SNIVELY

2,428,474

METHOD OF TUBE DRAWING

Filed March 27, 1944

3 Sheets-Sheet 2

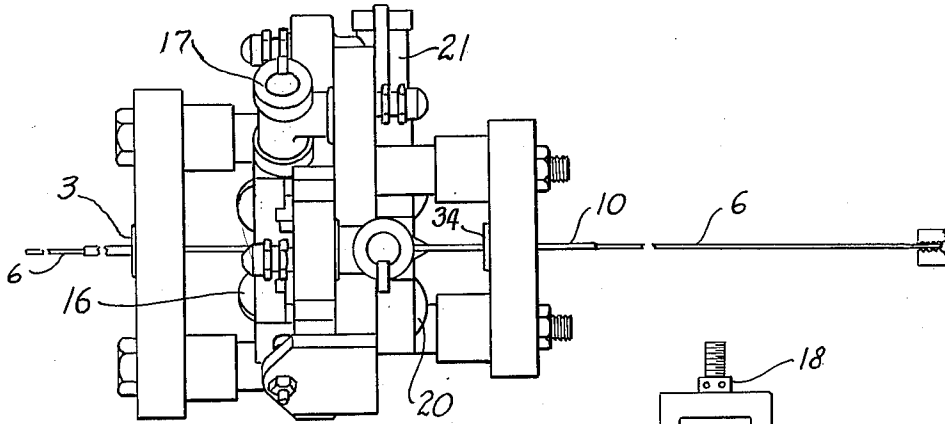


Fig. 5.

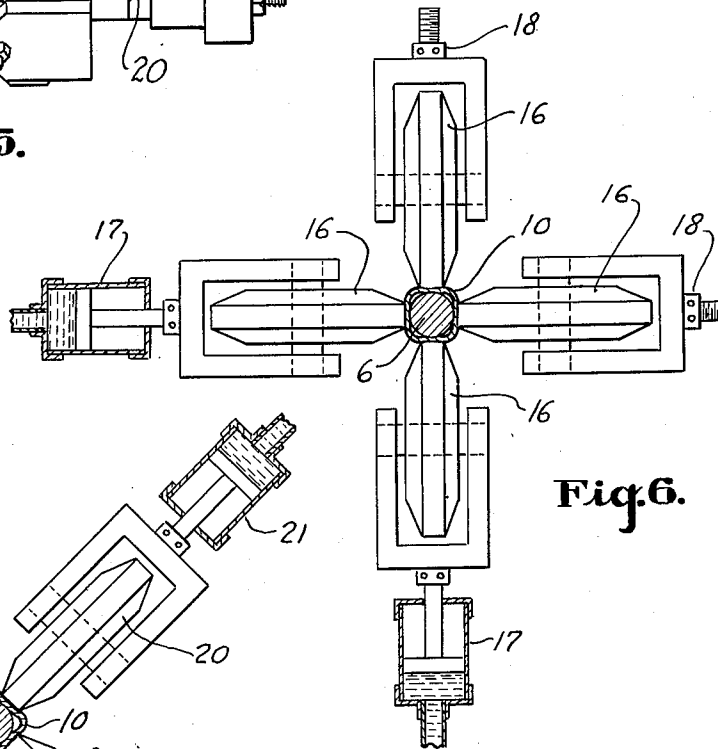


Fig. 6.

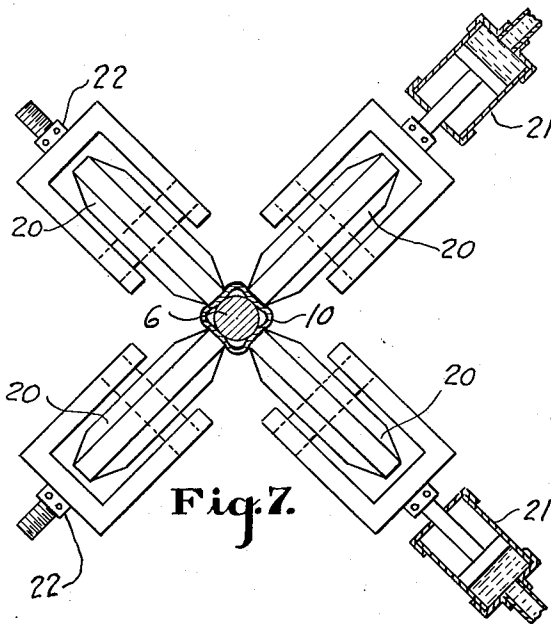


Fig. 7.

INVENTOR
Andrew J. Snively

BY
Barnes, Kiehl, Laughlin & Leisch
ATTORNEYS

Oct. 7, 1947.

A. J. SNIVELY

2,428,474

METHOD OF TUBE DRAWING

Filed March 27, 1944

3 Sheets-Sheet 3

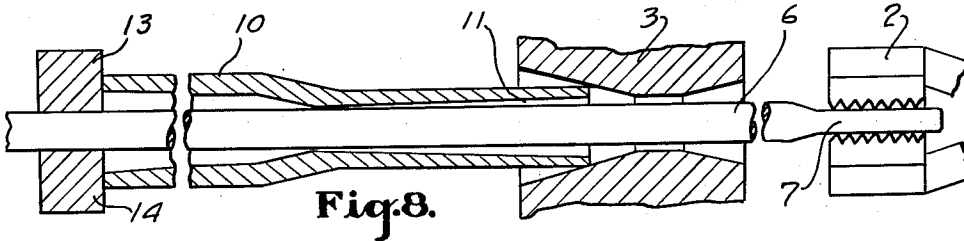


Fig. 8.

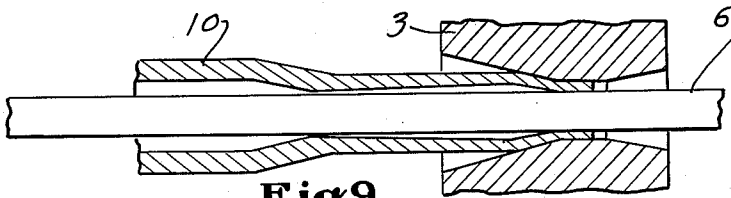


Fig. 9.

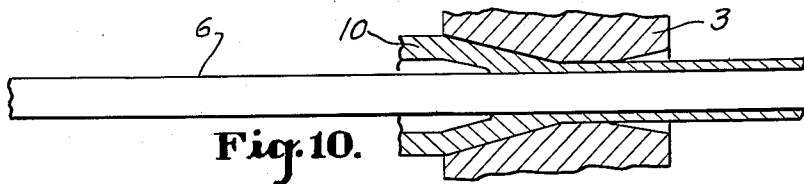


Fig. 10.

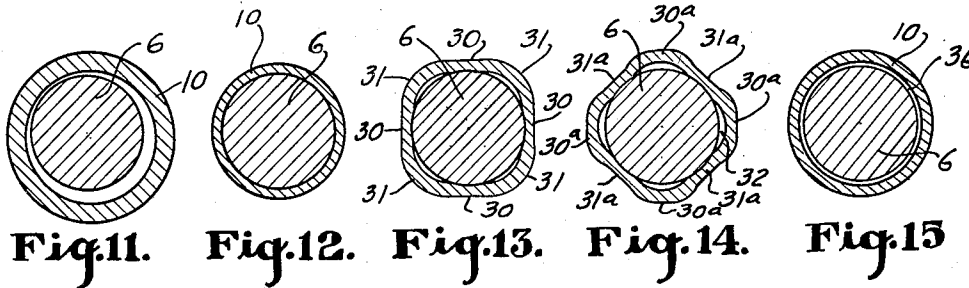


Fig. 11.

Fig. 12.

Fig. 13.

Fig. 14.

Fig. 15.

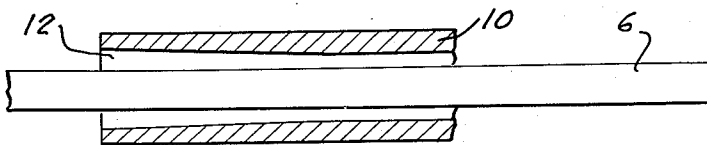


Fig. 16.

INVENTOR

Andrew J. Snively

BY

Barnes, Kinelle, Laughlin & Hirsch
ATTORNEYS.

UNITED STATES PATENT OFFICE

2,428,474

METHOD OF TUBE DRAWING

Andrew J. Snively, Huntington Woods, Mich., assignor to Bundy Tubing Company, Detroit, Mich., a corporation of Michigan

Application March 27, 1944, Serial No. 528,312

9 Claims. (Cl. 205—8)

1

This invention relates to the drawing of tubing and it has to do particularly with a type of draw wherein the wall of the tube is thinned and the tube elongated.

The invention is directed particularly to the art of drawing wherein the tube, throughout its length, is drawn down upon a mandrel which is at least as long as the tube. In such a procedure, the tube, at the beginning of the process, is relatively short and the mandrel relatively long. The tube and mandrel are pulled through a die so that the tube wall is reduced in thickness and the tube extended, the tube being drawn down tightly upon the mandrel. Heretofore several passes of the tube and mandrel were required in a single drawing action; thus the tube was drawn down tightly against the mandrel and subsequently one or more passes were required through means for loosening the tube from the mandrel. The tube must be loosened from the mandrel if it is to be removed therefrom and it must be loosened from the mandrel if a subsequent drawing pass is to be made in order to permit the elongation of the tube relative to the mandrel.

Heretofore, in this type of mandrel drawing, the leading end of the mandrel was considerably tapered or reduced in section and the leading end of the tube was reduced upon the leading end of the mandrel, so that the two could be passed into the draw die. The pulling instrument was applied to the tube and mandrel so that both the tube and the mandrel were pulled. The taper or reduction of the leading end of the mandrel weakened it and shortened the mandrel life. Moreover this arrangement also required additional operations to loosen the tube from the reduced and roughened leading end of the mandrel.

The general object of the invention is to provide improvements in the tube drawing art so that in a single pass, the tube is drawn upon the mandrel and then loosened from the mandrel so that the tube and mandrel are ready for a subsequent draw or can be readily separated if there is no subsequent draw. In this connection, a novel manner of pulling the tube through the drawing and loosening mechanism is provided wherein only the mandrel is subjected to the pulling action of the draw bench and the tube is pulled by reason of the frictional engagement between the tube and mandrel which engagement is caused by the die forcing the wall of the tube against the mandrel. In other words the mandrel pulls the tube by reason of the friction therewith. This, of course, sets up a problem

2

of starting the drawing action because the tube is initially and necessarily loose on the mandrel. Accordingly, the invention provides a novel manner of starting the draw to initially set up the frictional engagement between the mandrel and the tube. Inasmuch as the mandrel is under a substantial tension during the drawing action, it may be damaged or buckled when the trailing end of the tube leaves the drawing die because of the sudden release of the tension. The invention provides for a gradual reduction of this tension adjacent the trailing end of the tube so that the final release when the trailing end of the tube leaves the die is not such a severe action as to cause damage to the mandrel or other parts. In accordance with the invention one or more draw passes may be employed, depending upon the desires and objects to be obtained, and of course depending also upon the type of metal of which the tube is formed.

The accompanying drawings illustrate the method and one form of apparatus for carrying out the invention. In these drawings:

Fig. 1 is a view illustrating diagrammatically an apparatus for drawing tube in accordance with the present invention.

Fig. 2 is a view illustrating the base tube on the mandrel prior to the first draw.

Fig. 3 is a view similar to Fig. 2, showing the tube on its mandrel following the first draw.

Fig. 4 is a view illustrating the tube and its mandrel following the second draw.

Fig. 5 is a view illustrating the head containing the draw die, a set of pinching rolls and the loosening die.

Fig. 6 is a cross sectional view taken on line 6—6 of Fig. 1 showing some of the pinching rolls.

Fig. 7 is a sectional view taken on line 7—7 of Fig. 1 showing other pinching rolls.

Fig. 8 is a sectional view through the draw die, showing the tube and mandrel at the start of a draw and before the tube has entered the die.

Fig. 9 is a view similar to Fig. 8 showing the tube as its leading end has passed into the die.

Fig. 10 is a sectional view similar to Figs. 8 and 9, illustrating the drawing action after it is well started.

Fig. 11 is a cross sectional view taken substantially on line 11—11 of Fig. 1 showing the base tube and the mandrel prior to the drawing action.

Fig. 12 is a cross sectional view taken substantially on line 12—12 of Fig. 1 showing the tube and mandrel down stream from the draw die.

Fig. 13 is a sectional view taken substantially

on line 13—13 of Fig. 1 showing the results of the first group of pinching rolls.

Fig. 14 is a sectional view taken substantially on line 14—14 of Fig. 1 showing the action of the complete set of pinching rolls.

Fig. 15 is a sectional view taken substantially on line 15—15 of Fig. 1 down stream of the loosening die showing the drawn tube loosened on the mandrel.

Fig. 16 is a sectional view illustrating the mandrel and trailing end of the tube.

As shown in Fig. 1, there is a suitable draw bench 1 equipped with a pulling device at 2 of conventional construction. On the bench is a draw die 3 provided with a suitable passage and on the up stream side of which is a suitable container of lubricant through which the tube passes. The mandrel is illustrated at 6 and it has a length at least as great as and preferably greater than the length of the finished tube. This mandrel is preferably of the so-called piano wire or the like, having a high tensile strength and its leading end 7 is reduced in size where it is to be gripped by the puller 2. The purpose of reducing the leading end is so that the surfaces of the mandrel which become roughened or burred by the gripper 2 will not cut or scratch the interior of the tube when the mandrel is inserted therein. The tube 10 is passed over the mandrel and the base tube and mandrel prior to any drawing action may appear as substantially shown in Fig. 2.

Inasmuch as the puller 2 is applied only to the mandrel, means are required to enter the leading end of the tube into the die. To this end the leading end of the tube has its wall section weakened as by being thinned or reduced in cross section. As shown in Fig. 8, the leading end of the tube is provided with an internal tapering formation which thins the tube wall. This thinning may be done by subjecting the leading end of the tube to a swaging action or by machining or grinding the same. It is within the invention to reduce the leading end externally as well as internally. Also the trailing end of the tube is similarly treated as shown in Fig. 16 where the trailing end of the tube wall is reduced as shown at 12.

To start a draw, the tube is first passed over the mandrel and then the leading end of the mandrel is passed through the die as shown in Fig. 8 and through the pinching rolls, the loosening die and the wiper 37. The puller 2 is now applied to the leading end of the mandrel and the pulling action started. It will be observed that in the absence of any connection between the mandrel and the tube that the tube will not be pulled. To start the tube into the die, it is subjected to a pushing action, and one way to do this is by gripping the mandrel with a suitable gripping device similar to a large pair of pliers. The jaws 13 and 14 of the gripper are applied to the mandrel and come into an abutting relation with the trailing end of the tube. This forces the leading end of the tube into the die, this action being facilitated because of the weakened nature of the leading end of the tube caused by the thinning of the walls. After the leading end of the tube has passed into the die, it is forced down tightly upon the mandrel and when the frictional contact between the tube and mandrel is of sufficient length and the connection strong enough to pull the tube with the mandrel the plier jaws 13 and 14 are removed. The plier jaws 13 and 14 may be applied by hand. After 75

the drawing process is in operation, the die, tube and mandrel may appear as shown in Fig. 10. It must be pointed out, however, that the leading end of the mandrel at the beginning of a draw operation is not only threaded through the die but also passed through the pinching and loosening die structures as shown in Figs. 1 and 5.

The pinching rolls for treating the tube wall preparatory to loosening the wall from the mandrel are located down stream from the die as shown in Fig. 1. An advantageous construction is to employ a set of pinching rolls arranged in two groups of 4. One group as shown in Fig. 6 has 4 rolls each indicated at 16 with the rolls arranged at right angles to each other. The rolls may be idling rolls and are beveled adjacent their peripheries to provide a clearance relative to each other. Two of the rolls are applied to the tube by hydraulic pressure through the means of the cylinder and piston structures 17 while the opposing two are in fixed position although capable of adjustment by the nuts 18 on the threaded posts as indicated. This adjustment permits of adjusting the rolls for different size tubes and also 25 for adjusting the rolls to a proper central position.

As shown in Fig. 7 there is a second group of pinch rolls each indicated at 20. These rolls may be identical with the first group of rolls but are disposed at 45 degrees relative to the rolls of the first group. Two of these rolls may be applied to the tube by hydraulic pressure as indicated by the cylinder and piston structures 21 while the opposing two are adjustably fixed as at 22. A suitable lubricant may be applied to the tube between the draw die and the pinch rolls as indicated by a lubricant supply pipe 25 for discharging the lubricant directly on the tube.

Pinching rolls of this type have been termed 40 "Turk's head" rolls and their function is to flow the metal of the tube circumferentially with some resultant thinning of the tube wall so that the tube may be loosened from the mandrel. This function is illustrated in Figs. 13 and 14. In Fig. 12 of course the tube is very tightly applied to the mandrel. In fact the grip between the tube and the mandrel is so strong that it is employed as a pulling agency to pull the tube through the drawing die. The first group of rollers 16 apply 50 pressure to the tube at locations spaced 90 degrees apart and this thins the wall somewhat as illustrated at 30 and causes the metal to flow and bulge between the locations of roller contact as illustrated at 31. Thus the metal at the four locations 31 is forced away from and out of contact with the mandrel 6 as illustrated. The next group of rollers 20 engage the tube at bulged portions 31 and thin the metal somewhat as at 31a so as to cause a flow action with the result that the metal 55 between the locations of contact by the rollers is bulged away from the mandrel as indicated at 30a. It will be seen with reference to Fig. 14 that a considerable spacing is provided between the mandrel and the portions 30a as illustrated at 32. Thus the circumferential extent of the tube wall is increased. In other words, the interior periphery of the tube is enlarged over the circumference of the mandrel. At this point, however, the tube is still tightly applied to the mandrel particularly at locations 31a. To free the tube from the mandrel and to restore the tube to a rounded condition it is drawn through a rounding die 34 up stream from which the tube is subjected to a lubricant through means of supply pipe 35. This rounding die has an interior diameter less than

5

the maximum cross dimension of the tube in the form as shown in Fig. 14 and greater than the diameter of the mandrel plus twice the wall thickness of the tube at this point. The rather squared formation of the tube wall is thus brought back into rounded condition as shown in Fig. 15, with the tube wall thinned and enlarged over its condition as shown in Fig. 12 and thus loose on the mandrel as indicated by the spacing at 36. Down stream from the rounding die a wiper 37 is preferably disposed, particularly for the purpose of wiping the trailing end of the mandrel as it is drawn therethrough to facilitate a subsequent draw.

It will be appreciated that the mandrel is under a substantial tension and if this tension were suddenly released as the trailing end of the tube passed out of the draw die 3, the resultant shock and snap action might bend the mandrel and even cause damage to other parts. To meet this situation, the trailing end of the tube, as shown in Fig. 16, is gradually thinned or tapered so that the tension gradually reduces and the resultant shock and snap when the end of the tube leaves the draw die is minimized.

As illustrated in Fig. 5, the draw die, "Turk's head" rolls and rounding die may all be constructed as a compact unit assembly. Where the tube is to be given more than one draw as, for example, 2 draws, the mandrel and tube may appear relatively as indicated in Fig. 3 following the first draw pass. In this condition the tube is loose on the mandrel as shown in Fig. 15. This is necessary because in a subsequent draw, the tube is going to elongate on the mandrel to a condition as exemplified in Fig. 4. With the mandrel and tube in the condition as shown in Fig. 3 they may be again pulled through a drawing mechanism identical with the one described above including the draw die, "Turk's head" rollers and rounding die except for diameter size. To start the second or any draw subsequent to the first, the tube wall may be collapsed as by means of a tool similar to a pair of pliers with its jaws 40 and 41 applied to the tube with pressure. This causes a frictional engagement between the mandrel and the tube and as the mandrel is pulled through a draw die of a subsequent draw action, the leading end of the tube is pushed through the draw die by the friction caused by the jaws 40 and 41. It will be understood of course that since the tube wall has been thinned by the first draw that it is not so difficult to cause the leading end of the tube to enter the die of a second draw.

The number of rollers used in the "Turk's head" structure is of course subject to variation. Eight rollers are shown herein divided into two groups of 4. The larger the number of rollers used the less the variation in the wall thickness of the completed tube. Where a tube is required with an extremely accurate exterior surface the drawn tube may be passed through a sinking die to smooth and round the finished tube. In such a case the tube is preferably annealed before sinking.

Thus it will be observed that in a single pass the tube is drawn upon the mandrel and it is loosened from the mandrel so that the tube and mandrel may be separated or so that they are conditioned for a subsequent draw. The tightness with which the tube engages the mandrel may be appreciated when it is considered that the portion of the tube which tightly engages the mandrel for pulling purposes lies principally between the drawing die

6

and the first group of "Turk's head" rollers. This may be only a matter of a few inches.

The draw which may be effected with this arrangement is severe and therefore a substantial tube wall reduction can be had with a minimum number of passes. To exemplify this, an example is herewith given of the drawing of a tube made of 1010 steel, ordinarily called low carbon steel, it being understood of course that the invention is not limited to this example. In this example, the base tube had an original outside diameter of .375 in.; its wall was .028 in. thick; its interior diameter .319 in.; the mandrel had a diameter of .306 in. At this point it may be pointed out that some latitude is permissible in the clearance between the mandrel diameter and the interior diameter of the base tube. The interior diameter of the draw die was .327 in.; the base tube was 5½ ft. in length while the mandrel was 30 ft. long and draw bench 32 ft. long. Following the first draw, the outside of the diameter of the tube was .331 in.; its wall thickness was .0105 in. in thickness; its interior diameter .309 to .310 in. It will be observed that the interior diameter following the first draw was about .003 to .004 in. greater than the diameter of the mandrel and that the outside diameter was about .004 in. greater than the inside diameter of the die. This represents the enlargement of the tube effected by the pinch rollers and the rounding die representing a clearance of about .002 in. at 36 in Fig. 15. Following this draw, the tube had been extended to about 16 ft. in length as indicated at Fig. 2. On the next draw the interior diameter of the draw die was .318 in.; following the second draw pass the outside of the tube was .322 in.; the wall thickness was .006 in.; the inside diameter was about from .309 to .310 in. Here again it will be noted that the outside diameter of the tube following the second draw pass is about .004 in. greater than the inside diameter of the die and that the inside diameter of the tube remained the same as it was following the first draw pass or namely, about .309 in. to .310 in. Following the second draw, the length of the tube was about 28 ft. as represented in Fig. 4. In the above example, no attempt has been made to show any dimensional variations in the intermediate conditions as shown in Figs. 12, 13 and 14.

It will be observed that with two draw passes, there is a substantial reduction in the thickness of the tube wall and a substantial elongation of the tube. The amount of draw or metal flow obtainable in a pass may be varied, as this depends largely upon the nature and ductility of the metal of the tube. Following the first draw, the tube is loose upon the mandrel and can be removed if this is the total amount of reduction desired. The looseness of the tube as pointed out above, is necessary for a subsequent pass through the draw die because of the elongation of the tube. In this connection, the wiping of lubricant from the trailing end of the mandrel by wiper 37 is important. If there is too much lubricant on the trailing end of the mandrel during the second draw, which starts with the condition as shown in Fig. 2, where the tube wall has been substantially reduced in thickness, this lubricant passes into the tube around the mandrel as the mandrel is pulled through the die and as the tube elongates. The result is the building up of a hydraulic pressure within the already thinned tube and the pressures therein may become so great as to break or rupture the tube wall. Only a thin film of lubricant is needed between the tube and

7

mandrel because the relative axial movement occurs where the mandrel is loose within the tube. After the tube is drawn down upon the mandrel there is no further relative movement between the tube and mandrel.

I claim:

1. In the method of drawing tube wherein a mandrel is placed within the tube and the tube and mandrel are moved through a die so that the tube wall is reduced in thickness between the die and mandrel; the steps of applying pulling forces directly to and only to the mandrel, thereby causing the mandrel to move relative to the die, feeding the tube into the die to cause its wall to be forced into frictional engagement with the mandrel, discontinuing the feeding of the tube and pulling the tube through the die by the means of frictional engagement of the tube with the mandrel.

2. In the method of drawing tube wherein a mandrel is placed within the tube and the tube and mandrel are moved through a die so that the tube wall is reduced in thickness between the die and mandrel; the steps of placing the tube over the mandrel in loose and otherwise unattached relationship, applying pulling forces directly to the mandrel to cause the mandrel to move relative to the die, feeding the tube to cause its leading end to enter the die so that the wall of the tube is forced into frictional engagement with the mandrel, discontinuing the feeding of the tube and thereafter pulling the tube through the die by means of the frictional engagement of the tube with the mandrel.

3. In the method of drawing tube wherein a mandrel is placed within the tube and the tube and mandrel are moved through a die so that the tube wall is reduced in thickness between the die and mandrel; the steps of weakening the leading end of the tube, placing the tube on the mandrel in loose and otherwise unattached relationship, pulling the mandrel relative to the die, feeding the leading end of the tube into the die so that it is forced into frictional engagement with the mandrel, discontinuing the feeding of the tube and pulling the tube through the die by the means of its frictional engagement with the mandrel.

4. In the method of drawing tube wherein a mandrel is placed within the tube and the tube and mandrel are moved through a die so that the tube wall is reduced in thickness between the die and mandrel; weakening both the leading and trailing ends of the tube, placing the tube over the mandrel, pulling the mandrel to cause it to move relative to the die, feeding the leading end of the tube into the die to cause its wall to be forced into engagement with the mandrel, discontinuing feeding of the tube and pulling the tube through the die by means of frictional engagement of the tube with the mandrel, the weakening of the trailing end of the tube serving to gradually reduce the tension on the mandrel to reduce the shock when the trailing end of the tube passes through the die.

5. In the method of the drawing tube wherein a mandrel is placed within the tube and the tube and mandrel are moved through a die so that the tube wall is reduced in thickness between the die and mandrel; treating the leading end of the tube to give its wall a tapering form, placing the tube over the mandrel in loose and otherwise unattached relationship, applying pulling forces to the mandrel to cause the mandrel to move relative to the die, feeding the tube into the die

8

to cause its leading end to be forced into frictional engagement with the mandrel, discontinuing the feeding of the tube and pulling the tube through the die by means of the frictional engagement of the tube with the mandrel.

6. In the method of drawing tube wherein a mandrel is placed within the tube and the tube and mandrel are moved through a die so that the tube wall is reduced in thickness between the die and mandrel; treating the leading end of the tube to give its wall a tapering form, similarly treating the trailing end of the tube, placing the tube over the mandrel, applying pulling forces to the mandrel to cause the mandrel to move relative to the die, feeding the tube into the die to cause its leading end to be forced into frictional engagement with the mandrel, discontinuing the feeding of the tube and pulling the tube through the die by means of the frictional engagement of the tube with the mandrel, the tapering section at the trailing end of the tube serving to gradually reduce the tension of the mandrel to reduce the shock of the release when the trailing end of the tube moves through the die.

7. In the method of drawing tube wherein a mandrel is placed within the tube and the tube and mandrel are moved through a die so that the tube wall is reduced in thickness between the die and mandrel; the steps of placing the tube over the mandrel in loose and otherwise unattached relationship, inserting the leading end of the mandrel through a draw die and loosening mechanism, pulling the mandrel lengthwise, feeding the tube into the draw die to cause it to be forced into frictional engagement with the mandrel, discontinuing the feeding of the tube and pulling the tube through the draw die by means of the frictional engagement of the tube with the mandrel and then through the loosening mechanism to loosen the tube on the mandrel.

8. In the method of drawing tube wherein a mandrel is placed within the tube and the tube and mandrel are moved through a die so that the tube wall is reduced in thickness between the die and the mandrel; the steps of placing the tube over the mandrel in loose and otherwise unattached relationship, applying pulling forces to the mandrel to cause the mandrel to move relative to the die, applying force to the tube to cause its leading end to enter the die so that the wall of the tube is forced into frictional engagement with the mandrel to thereby establish the sole connection between the tube and the mandrel, discontinuing the application of force to the tube and pulling the tube through the die by means of the frictional engagement of the tube with the mandrel.

9. In the method of drawing tube wherein a mandrel is placed within the tube and the tube and mandrel are moved through a die so that the tube wall is reduced in thickness between the die and the mandrel; the steps of placing the tube over the mandrel in loose and otherwise unattached relationship, applying pulling forces to the mandrel to cause the mandrel to move relative to the die, weakening the leading end of the tube so that it may be relatively easily ensmallled by the die, applying force to the tube to cause its leading end to enter the die so that the wall of the tube is forced into frictional engagement with the mandrel to thereby establish the sole connection between the tube and the mandrel, discontinuing the application of force to the tube and pulling

the tube through the die by means of the frictional engagement of the tube with the mandrel.
ANDREW J. SNIVELY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date		Number
2,074,271	Peters	Mar. 16, 1937	10	5,752
				3,333
				511,791

Name	Date
Engelbertz	June 15, 1937
Ivins	Aug. 16, 1898
Von Forster	Nov. 22, 1932
Linderme	June 9, 1925

FOREIGN PATENTS

Country	Date
Great Britain	Mar. 8, 1902
Great Britain	Nov. 25, 1867
Germany	Nov. 1, 1930