Dec. 19, 1939. W. W. COTTER, SR 2,183,861

METHOD OF AND MEANS FOR MACHINING INTERIOR SURFACES OF TUBES

Filed March 23, 1939 2 Sheets-Sheet 1

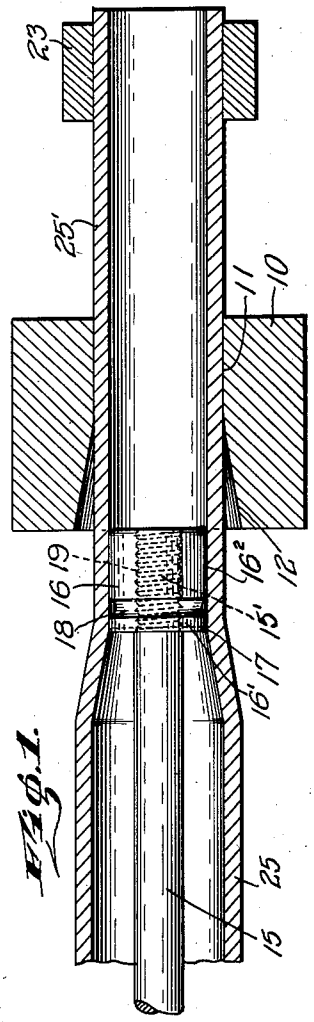

Fig. 1.

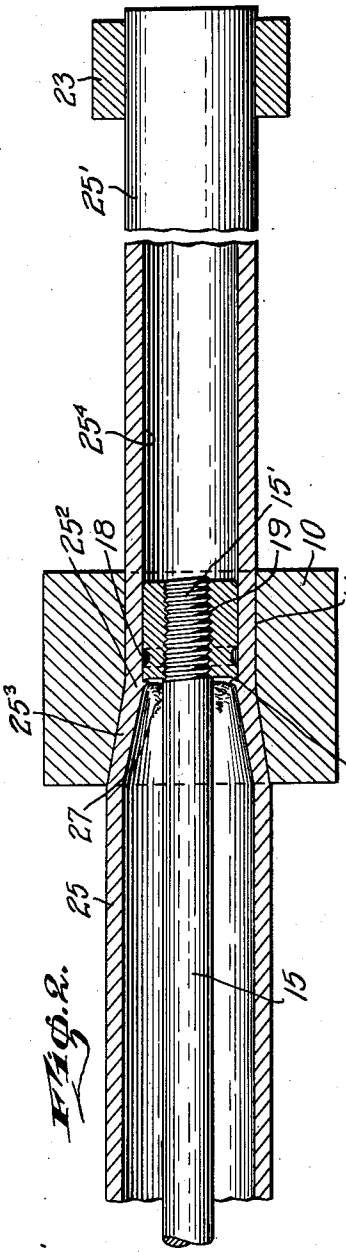

Fig. 2.

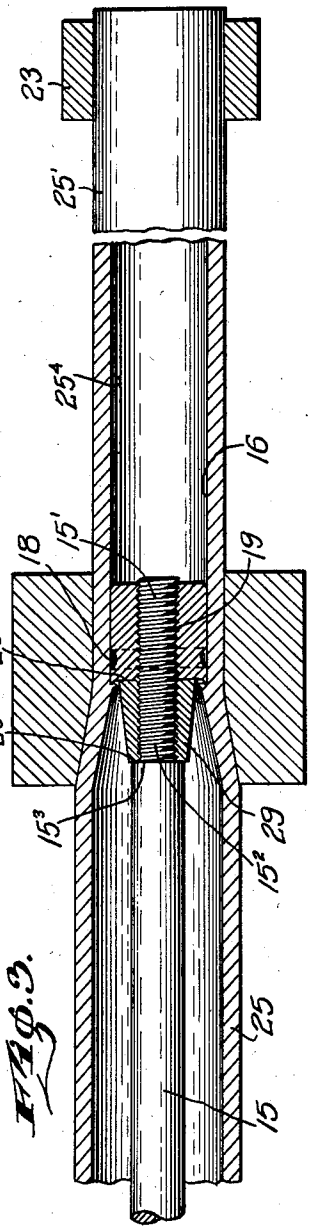

Fig. 3.

INVENTOR
William W. Cotter, Sr.
BY Kenyon & Kenyon
ATTORNEYS

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Fig. 4.

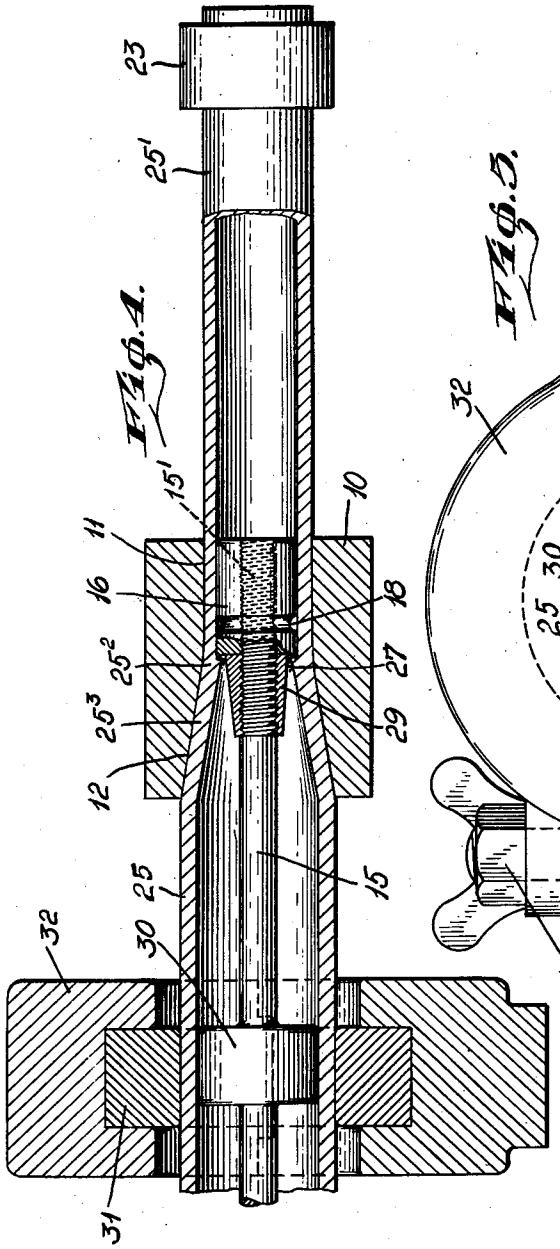
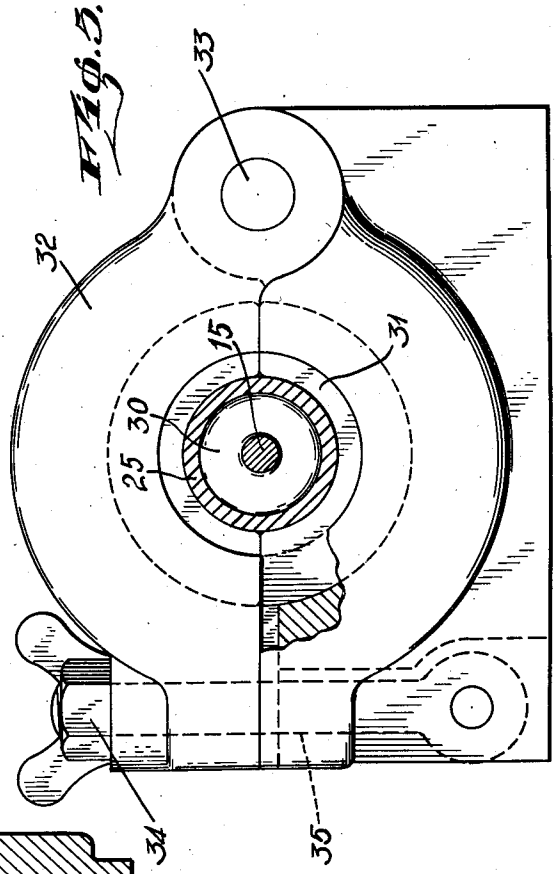


Fig. 5.



INVENTOR
William W. Cotter, Sr.
BY
Kenyon & Kenyon
ATTORNEYS.

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METHOD OF AND MEANS FOR MACHINING INTERIOR SURFACES OF TUBES

William W. Cotter, Sr., Stratford, Conn., assignor to Bridgeport Brass Company, Bridgeport, Conn., a corporation of Connecticut

Application March 23, 1939, Serial No. 263,631

23 Claims. (Cl. 205—7)

This invention relates to methods and means for machining the interior surfaces of tubes.

In metal alloy tubes employed in, for example, surface condensers, pump barrels and the like, an interior surface as nearly perfect as possible is of great importance. Seamless tubing particularly as generally manufactured, frequently possesses defects in its interior surfaces which must be eliminated before it can be applied to the uses mentioned or to other uses requiring substantially perfect interior surfaces.

A known method of attempting to prepare seamless tube to meet these requirements consists of machining the initial blank or casting from which the tube is subsequently made. Such machining is expensive and somewhat ineffectual because performed at the start of the tube manufacturing operations rather than substantially at the end thereof. With such timing, imperfections creep into the inner tube surface between the machining process and the final tube manufacturing steps.

It is among the objects of the present invention to provide a method and means for producing tubing having substantially perfect interior surfaces, to provide a method wherein the finishing of the tube surfaces is effected very much nearer to the final processing steps required to produce tubing of the desired dimensions, and to provide means for effectively carrying out the method as a result of which the finished tubing has the desired highly finished interior surfaces.

It is a further object of this invention to provide means for carrying out the process which is readily adaptable for a great variety of differently dimensioned tubings.

It is a further object of this invention to provide means of the character referred to adapted for use in connection with tubing which is initially somewhat crooked.

Yet another object is to provide cheap and simple methods and means which substantially reduce the operating and manufacturing costs of tube production and yield superior internally finished tubing.

To the accomplishment of the foregoing and such other objects as may hereinafter appear, this invention comprises the novel method and novel combination and arrangement of parts hereinafter described and then sought to be defined in the appended claims, reference being had to the accompanying drawings forming part hereof and which shows, merely for the purposes of illustrative disclosure, preferred embodiments of my invention, it being expressly understood, however, that various changes may be made in practice within the scope of the claims without digressing from my inventive idea.

In the drawings in which similar reference characters denote corresponding parts;

Fig. 1 is a sectional elevation illustrating the tubing arranged in initial position in a reducing die with the novel tube interior finishing means in initial position prior to tube drawing;

Fig. 2 is a similar view showing another position of said tubing and said tube interior finishing means during the drawing operation with said finishing means in sectional elevation;

Fig. 3 is a view similar to Fig. 2 illustrating in sectional elevation a modified form of tube interior finishing means;

Fig. 4 is a sectional elevation similar to Fig. 3 of a modified embodiment of this invention including straightening means; and

Fig. 5 is an end view of the guide part of the structure shown in Fig. 4.

Referring to the drawings, 10 denotes a reducing die mounted in a draw bench of customary design (not shown). The die 10 also of known form has a cylindrical bearing portion 11 and a conical bearing portion 12. If desired, and sometimes advantageously, the bearing portion 11 may be slightly conical, serving thereby to reduce the thickness of the walls of the tube being drawn.

A usual type of plug rod 15 which is made longitudinally adjustable as in ordinary tube drawing practice is provided. This rod is threaded at its forward end 15' to receive a special plug or triblet 16 of special design. Plug or triblet 16, of tool steel or the like, has a cutting edge 17. In the embodiment shown the cutting edge is formed as an overhanging extension of the side wall of the plug, the inner face 16' of the said plug being somewhat concave to produce the said overhanging cutting edge. The wall surface 16^2 of the plug is provided with an annular oil or grease groove 18 adjacent the cutting edge for the purpose of providing lubrication. The plug has a central axially extending threaded bore 19 and may thus be screwed to the plug rod 15 on its threaded portion 15'.

Drawing tongs 23, or the like of well known type, are provided on the draw bench for pulling or drawing tubing through the die.

To operate the device, a tube 25 larger in diameter than the cylindrical diameter of the die, and having a thickness approximating the annular space between the plug or triblet 16 and the cylindrical portion 11 of the die is pointed or reduced in diameter at one end 25' according

to the practice customarily employed in drawing tubes. The plug or triblet 16 and the plug rod 15 are then inserted into the tube 25 until the pointed end 25' of the latter is reached. The pointed end 25' is then projected through the die 10, grasped by the tongs 23 of the draw bench (not shown) and the tube drawn through the die and over the plug or triblet 16.

As the drawing begins, the tube 25 and plug rod 15 move forwardly towards the die 10, the plug or triblet 16 being limited in its forward motion and coming to rest in the cylindrical portion 11 of the die. The outside tube diameter is reduced by the conical portion 12 of the die to the diameter of the cylindrical portion 10 and its wall thickness at 25^2 somewhat increased as shown in Fig. 2. The dimensions of the tube plug and die are so chosen that as the portion 25^3 of the tube which assumes the tapered form shown in Fig. 2 reaches the cutting edge 17 of the plug or triblet 16, by virtue of its thickened wall portion 25^2, it will be somewhat less in internal diameter than said cutting edge by a predetermined amount, which amount it is desired to remove from the interior surface of the tube. As the drawing of the tube proceeds, the cutting edge 17 will remove in the form of chips or shavings 27 the aforesaid predetermined amount of material leaving the interior surface 25^4 of the tube which then passes over the smooth portion 16^2 of the plug free from imperfections customarily termed "slivers", "spills" or "surface imperfections". The surface imperfections sometimes consist of slight depressions in the interior surface and by a suitable combination of die and plug, with relation to the tube diameter prior to the drawing operation, sufficient material may be readily removed to completely remove these indentations and leave the interior surface entirely free from defects of any character.

It is desirable though not essential that the wall surface 16^2 of the plug 16, except for the groove 18, should be very smooth. It may be highly polished. The result of such smoothness or polish imparts a highly finished appearance to the inner tube surface 25^4 because of the comparatively tight fit of the tube between the cylindrical portion of the die and the plug between which the tubing is drawn after passing the cutting edge 17. This tight fit causes pressure between the shaved surface and the plug surface and helps to finally smooth the tubing surface.

Usually a single draw is sufficient to produce a tubing of desired dimensions and interior finish. It is, of course, possible to repeat the operation and in such case with each successive draw a die and plug of appropriately reduced diameter would normally be used and preferably smaller amounts of metal are shaved off on each successive draw.

It is sometimes desirable to limit the thickness of the cut removed by the cutting edge 17. To this end the plug rod 15 as shown in Fig. 3 may be somewhat reduced in diameter at 15^2 behind its threaded end 15' to form a shoulder 15^3. A collar 29 which flares outwardly toward the plug 16 is mounted on the reduced portion 15^2, preferably by threaded engagement therewith, with its rear end 29' bearing against the shoulder 15^3. The larger diametered forward end 29^2 is adapted to rest on or abut against the inner face 16' of the plug or triblet 16. Its extreme diameter is somewhat less than that of plug 16 and may be so chosen as to limit the cutting depth of the cutting edge 17 to any amount desired. This tapered collar 29 is, of course, interchangeable with different sizes of plugs 16.

In Fig. 4 a device is shown which is essentially similar to those shown and described in connection with Figs. 1 to 3, except that guide means are used to assist the handling of crooked tubes. Tubes are sometimes crooked and the crookedness of the tube causes difficulty in that the tube does not enter the reducing die evenly. The means shown in Fig. 4 includes the elements shown in Fig. 3, these elements being indicated by corresponding reference characters. In addition the means shown in Fig. 4 includes guide means comprising a guiding plug 30 surrounded by an annular die 31. The dimensions of the plug 30 and annular die 31 are such as to place a drag on the tube so that it enters the die 10 evenly, the plug 30 fitting somewhat loosely in the tube. The plug 30 is attached to the guide rod 15 by any suitable means not shown.

The die 31 can be mounted in any desired way as by mounting it on a split clamping frame 32 hinged (as shown more clearly in Fig. 5) at hinge 33 and provided with a suitable clamping means which may, for example, be in the form of one or more hinged bolts 35 having wing nuts 34 thereon so that the clamping frame can be opened to remove the die 31 and so that the die 31 can be renewed or replaced with a die of different size. The clamping frame 32 is preferably provided with suitable means (not shown) so that the clamping frame is capable of lateral and vertical adjustment relative to the die 10 so that the opening in die 31 can be in alignment with the opening in die 10.

In the event that the tubing is only slightly crooked the plug 30 can be omitted and the straightening effect produced only by the die surrounding the periphery of the tube. Alternatively, the plug 30 can be used by itself to exert a straightening or aligning effect on the tubing entering the die 10. While the device shown in Fig. 4 is shown as including the tapered collar 29, the collar 29 may be omitted so that the die and shaving part of the apparatus will be similar to and function according to that shown and described in connection with Figs. 1 and 2.

The method steps contemplated in this invention, it will be noted, broadly comprise providing unfinished tubing having substantially larger diameter than that finally required, peripherally confining the tubing with such severity as to reduce the diameter of said tubing in a reducing die (which normally results in a simultaneous thickening of the tubing wall), and cutting or shaving away a portion of the thickened wall with the cutting edge of the plug or other cutting means, during the confinement or simultaneously with the reducing operation. Preferably the reduced shaved tubing is drawn over the smoothing surface 16^2 of the plug to give a final smoothing or finishing to the shaved surface. The number of reductions, shavings and smoothings is optional depending upon particular needs. While the tubing is described as being drawn through the die 10, the same effect is also produced by moving the die relative to the tubing, in either case the movement of the tubing relative to the die being responsible for progressively reducing and cutting or shaving the tubing as above described. These operations may be combined with the imposition of a drag on the tub-

ing on the outside, or inside, or both, in order to straighten the tubing prior to reducing the diameter of the tubing and cutting or shaving away the interior of the tubing.

The herein described machining method it will be noted performs the machining operation on the tube at a point in the tube manufacturing process substantially near the finished dimensions of the tube. As a result, such imperfections which would tend to creep into the tube surface in a method embodying machining before the tube drawing operation are materially reduced in magnitude and, in fact, substantially eliminated. The finished tubing made according to the new method and with the new device produce a superior finished tubing with a highly smooth polished interior surface. The tubing so produced is particularly suitable for surface condensers, pump barrels and for all other uses requiring substantially perfect inner surfaces.

While I have described preferred forms of means and a preferred sequence of operating steps, it is to be understood that structural variation and variation in processing steps are contemplated as within the scope of my invention. I do not therefore wish to be limited to the exact details shown and described, the scope of this invention being governed by the language of the following claims.

I claim:

1. In a method for producing tubing having an interior surface substantially free from imperfections, the steps comprising providing tubing of substantially larger diameter than that required, permanently reducing the diameter of said tubing while maintaining its original cross-sectional configuration and simultaneously cutting away undesirable portions of the entire internal tubing wall.

2. In a method for producing tubing having an interior surface substantially free from imperfections, the steps comprising providing tubing of substantially larger diameter than that required, permanently reducing the diameter of said tubing while maintaining its original cross-sectional configuration and simultaneously cutting away undesirable portions of the internal tubing wall and finally smoothing the entire internal surface of the tubing after the cutting operation.

3. In a method for producing tubing having an interior surface substantially free from imperfections, the steps comprising providing tubing of substantially larger diameter than that required, progressively subjecting the tubing to peripheral confinement sufficiently severe to reduce the diameter of said tubing while simultaneously thickening the tubing walls and progressively cutting away a portion of the thickened wall internally of said tubing during said confinement.

4. In a method for producing tubing having an interior surface substantially free from imperfections, the steps comprising providing tubing of substantially larger diameter than that required, progressively subjecting the tubing to peripheral confinement sufficiently severe to reduce the diameter of said tubing, progressively cutting away a portion of the internal wall of said tubing during said confinement and thereafter imparting a final smoothing to the internal wall by progressively moving said internal wall of said tubing over a smoothing surface in pressure contact with said internal wall during said confinement.

5. In a method for producing tubing having interior surfaces substantially free from imperfections, the steps comprising providing tubing of substantially larger diameter than that required, progressively subjecting the tubing to peripheral confinement sufficiently severe to reduce the diameter of said tubing while simultaneously thickening the tubing walls and progressively cutting away a portion of the thickened wall internally of said tubing while said tubing is confined to substantially the minimum outside diameter produced by said peripheral confinement.

6. In a method of producing tubing having an interior surface substantially free from imperfections, the steps comprising providing tubing of substantially larger diameter than that required, progressively subjecting the tubing to peripheral confinement sufficiently severe to reduce the diameter of said tubing, progressively cutting away a portion of the internal tubing wall during said confinement and progressively imposing a drag on the tubing wall prior to the confining step tending to straighten said tubing.

7. In apparatus of the character described, in combination, a reducing die, cutting means adapted to cut over the entire inner surface of tubing treated in said apparatus, means for maintaining said cutting means within said die leaving an annular space between said cutting means and the inner wall of said die, and means for moving tubing relative to said die through said annular space and over said cutting means, said die and cutting means being arranged to simultaneously confine said tubing and free its entire internal surface of imperfections.

8. In apparatus of the character described, in combination, a reducing die, cutting means, means for maintaining said cutting means within said die leaving an annular space between said cutting means and the inner wall of said die, means for moving tubing relative to said die through said annular space and over said cutting means, said die and cutting means being arranged simultaneously to confine said tubing and free its internal surface of imperfections, and straightening means maintained in alignment with said die adapted to straighten tubing entering said reducing die, said straightening means comprising a straightening die adapted to fit about the periphery of said tubing and impose a peripheral drag upon said tubing when said tubing is moved therethrough.

9. In apparatus of the character described, in combination, a reducing die, cutting means, means for maintaining said cutting means within said die leaving an annular space between said cutting means and the inner wall of said die, means for moving tubing relative to said die through said annular space and over said cutting means, said die and cutting means being arranged simultaneously to confine said tubing and free its internal surface of imperfections, straightening means maintained in alignment with said die adapted to straighten tubing entering said reducing die, said straightening means comprising a straightening die adapted to fit about the periphery of said tubing and impose a peripheral drag upon said tubing when said tubing is moved therethrough, a plug adapted to fit within the interior of said tubing, and means to maintain said plug within said straightening die upon moving said tubing through said straightening die.

10. In apparatus of the character described, in combination, a reducing die having a substantially cylindrical bearing portion and a conical

bearing portion, a rod supported in front of said die in axial alignment with said cylindrical bearing portion, cutting means supported on said rod and drawing means for drawing tubing through said die and over said cutting means, said die and cutting means being arranged to simultaneously peripherally confine and reduce in diameter said tubing and to cut the inner wall of said tubing to free said inner wall of surface imperfections upon drawing said tubing through said die.

11. In apparatus of the character described, in combination, a reducing die, a plug, means for maintaining said plug within said die leaving an annular space between said plug and the inner wall of said die, cutting means adjacent one end of said plug and means for moving tubing relative to said die through said annular space and over said cutting means, said die and cutting means being arranged to simultaneously peripherally confine and reduce the diameter of said tubing and cut along the entire surface of the inner wall of said tubing to free said inner wall of surface imperfections upon moving said tubing through said die.

12. Apparatus according to claim 11 and wherein the said plug is adapted to compress the said tubing between said plug and said die to smooth the inner surface of said tubing after said cutting means has cut the inner wall of said tubing upon moving said tubing through said die.

13. In apparatus of the character described, in combination, a reducing die having a substantially cylindrical bearing portion and a tapered bearing portion, means for moving tubing relative to said die through said die, a rod supported axially with respect to said cylindrical bearing portion, and cutting means mounted on said rod for cutting away a part of the inner wall of tubing moved through said die.

14. In tube drawing apparatus, in combination, a reducing die having a tapered bearing portion and a substantially cylindrical bearing portion at the smaller end of said tapered portion, means for drawing tubing through said die, a plug rod, means for maintaining said plug rod within said die, a plug fixed to said rod axially of said cylindrical portion of said die, said plug having cutting means adjacent the end of said plug nearest said tapered portion of said die arranged for cutting away a part of the inner wall of tubing drawn through said die to free said inner wall of said tubing of surface imperfections.

15. In tube drawing apparatus, the combination according to claim 14 and in which the cutting means is maintained within said die substantially where said tapered portion of said die meets said cylindrical portion of said die.

16. In tube drawing apparatus, the combination according to claim 14 and which comprises a second plug fixed to said plug rod in front of said tapered portion of said die, said second plug being arranged to guide and straighten tubing entering said die.

17. In tube drawing apparatus, in combination, a reducing die having a tapered bearing portion and a substantially cylindrical bearing portion at the smaller end of said tapered portion, means for drawing tubing through said die, a plug rod axially supported with respect to said cylindrical bearing portion, and cutting means mounted on said plug rod for cutting away a part of the inner wall of tubing drawn through said die, said means comprising a plug member having a cutting edge at one end and an annular groove on said member adjacent said cutting edge.

18. In tube drawing apparatus comprising a reducing die and a plug rod, a plug member attachable to said rod and having an annular cutting edge at one end for cutting away throughout its entire surface a part of the inner wall of tubing drawn through said apparatus.

19. In tube drawing apparatus comprising a reducing die and a plug rod, a plug member attachable to said rod having an annular cutting edge at one end for cutting away throughout its entire surface a part of the inner wall of tubing drawn through said apparatus and means for limiting the depth of cut of said edge.

20. Cutting means for use in tube drawing apparatus comprising a plug member having a cutting edge at one end and an annular groove in the surface thereof adjacent said cutting edge for lubricating medium.

21. Cutting means for use in tube drawing apparatus comprising a cylindrical plug member having an annular cutting edge at one end and an annular groove in the surface thereof adjacent said cutting edge for lubricating medium.

22. Cutting means for use in tube drawing apparatus comprising a cylindrical plug member having an annular cutting edge at one end, an annular groove in the surface thereof adjacent said cutting edge for lubricating medium, means for attaching said plug member in said apparatus and means for limiting the depth of cut of said cutting edge.

23. Cutting means for use in tube drawing apparatus comprising a cylindrical plug member having a smooth surface and provided with a cutting edge at one end contiguous with said surface, said member having an annular groove in said surface adjacent said cutting edge for lubricating medium, and means for attaching said plug member in said apparatus.

WILLIAM W. COTTER, SR.

CERTIFICATE OF CORRECTION.

Patent No. 2,183,861. December 19, 1939.

WILLIAM W. COTTER, SR.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, first column, line 47, claim 2, before the word "internal" insert entire; line 48, same claim, strike out the word "entire"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 6th day of February, A. D. 1940.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.