

Dec. 7, 1943.

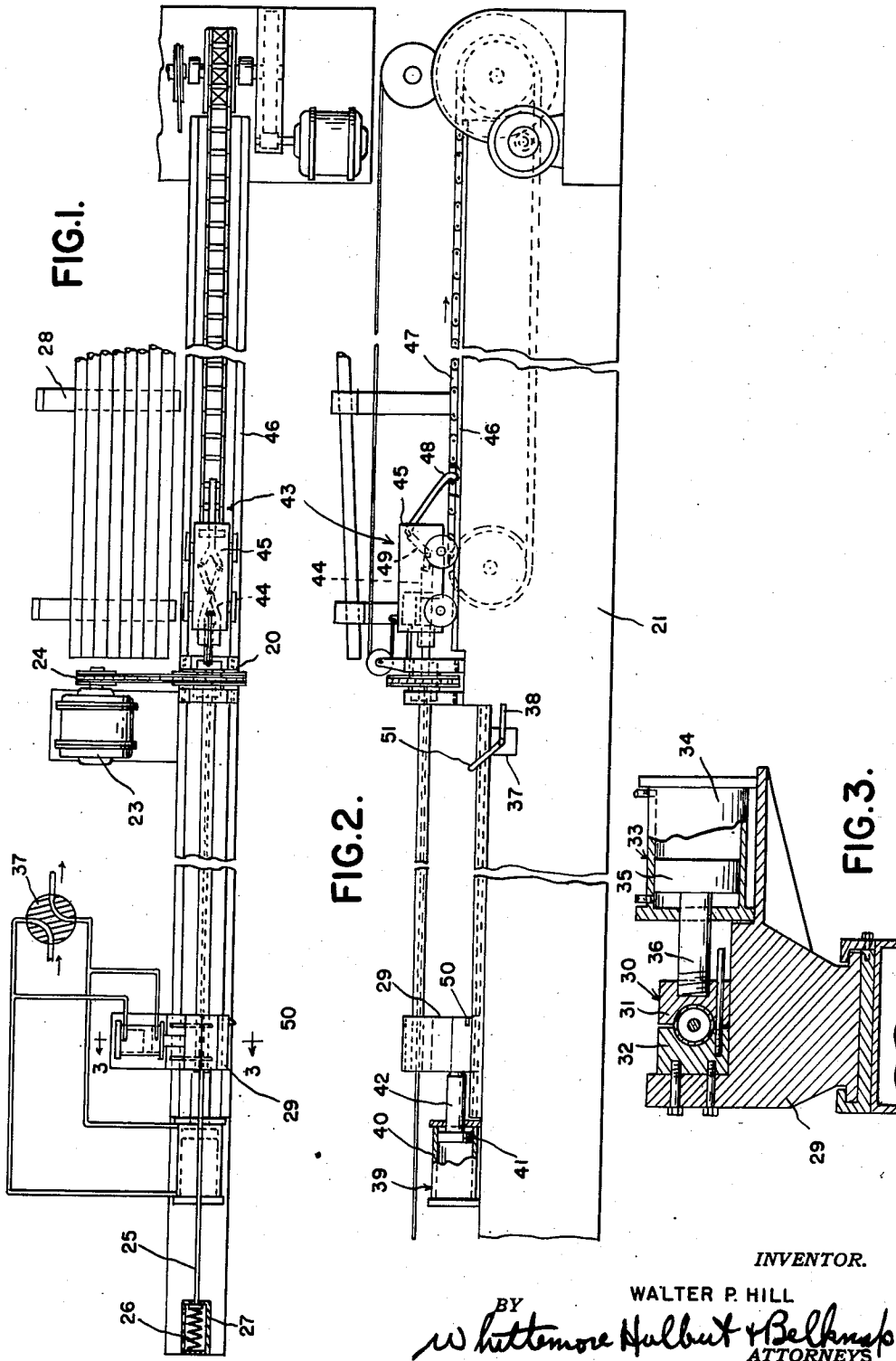
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2,335,939

METHOD AND APPARATUS FOR DRAWING AND REDUCING TUBULAR STOCK

Filed Oct. 13, 1941

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

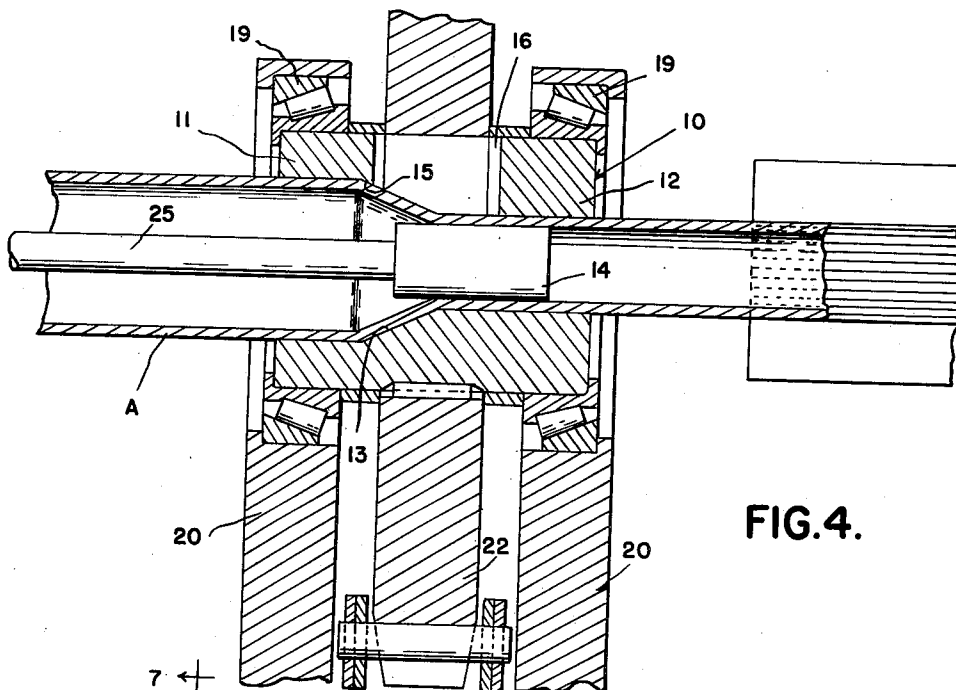


FIG. 4.

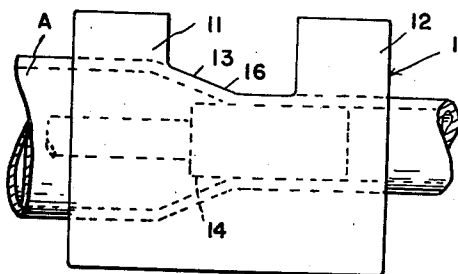


FIG. 5.

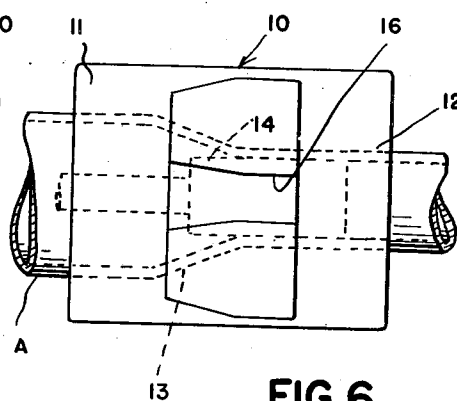


FIG. 6.

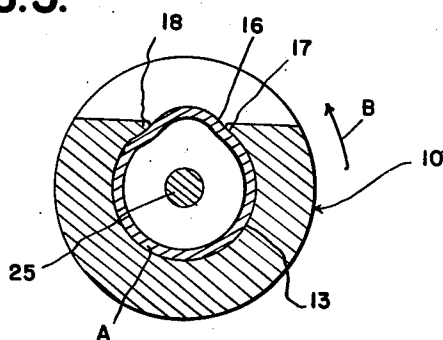


FIG. 7.

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METHOD AND APPARATUS FOR DRAWING
AND REDUCING TUBULAR STOCK

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10 Claims. (Cl. 205—7)

This invention relates to an improved method and apparatus for drawing and reducing tubular stock.

In drawing metal tubing in the past, it has been customary to first point one end of a length of tubular stock to enable this end to be extended through the drawing die into engagement with a drawbench. The remainder of the stock is then pulled through the die by movement of the bench in a direction away from the die. The amount of pull required on the pointed end of the stock depends upon the extent of reduction and the latter depends on the tensile or yield strength of the particular stock drawn. For example, if a large reduction is attempted with the above method of drawing, the pull required to draw the stock through the reducing die increases to such proportions that the end of the tubular stock breaks off. It follows, therefore, that when a large reduction of the stock is required, several separate drawing and pointing operations are necessary. This procedure consumes valuable time and appreciably increases the cost of manufacture.

It is, therefore, one of the principal objects of this invention to provide a method and apparatus capable of effecting a substantially greater reduction in the stock during a single drawing operation without fracturing, buckling or otherwise harming the stock. In general, the above results are obtained by reducing the stock with a rotatable reducing die during the drawing operation. As will be presently set forth, the reducing die works the stock to a plastic state and controls distribution of the stock so that greater reductions may be obtained during the drawing operation without the necessity of increasing the pulling force to a point where breakage is liable to occur.

Another object of this invention is to provide a rotatable reducing die having provision at the entrant end for confining the stock throughout its circumference to thereby heat the stock sufficiently to enable the same to be satisfactorily worked and also having a relief portion for subsequently relieving confinement of the stock in the reducing die for a sufficient portion of its circumference to enable successive portions of the stock to freely distort or deform into the relief portion of the reducing die. As a result, the stock may be substantially reduced during the drawing operation without the danger of stressing the stock to the point where it is liable to fracture or buckle.

Another object of this invention is to work the

stock during the drawing operation by one or more of the edges forming the boundary of the relief portion in the reducing tool. With this construction, any enlargement of the stock extending into the relief portion of the die is ironed out and the excess stock is properly distributed.

Still another object of this invention is to accurately control both the inside and outside diameters of the reduced tubing during the drawing operation. In accordance with this invention, the inside diameter of the reduced tubing is controlled by locating a mandrel in the delivery end of the die having a diameter corresponding to the inside diameter of the reduced tubing and the specified outside diameter of the tubing is obtained by predetermining the inside diameter of the delivery end portion of the die.

A further object of the present invention is to provide means at one side of the die for initially advancing a length of tubular stock to extend one end of the stock through the reducing die to the opposite side of the latter where it may be gripped by a suitable stock pulling mechanism. As a result of this feature, the pointing operation heretofore considered necessary before drawing the stock is eliminated.

A still further feature of this invention is to hold the length of tubular stock against rotation with the reducing die during movement of the stock through the die by clamping means movable with the stock and engageable with the free end of the tubular stock.

Still another object of this invention is to provide means for rendering the initial stock advancing means inoperative in timed relation to the operation of the stock pulling mechanism and for releasing the clamping means from the stock as this means approaches the reducing die.

The foregoing, as well as other objects, will be made more apparent as this description proceeds, especially when considered in connection with the accompanying drawings, wherein:

Figure 1 is a semidiagrammatic plan view of one type of apparatus that may be successfully employed to draw and reduce a length of tubing in accordance with this invention;

Figure 2 is a side elevational view of a portion of the construction shown in Figure 1;

Figure 3 is a sectional view taken substantially on the plane indicated by the line 3—3 of Figure 1;

Figure 4 is a sectional view through the reducing die;

Figure 5 is a side elevational view of the reducing die;

Figure 6 is a top plan view of the reducing die; and

Figure 7 is a cross sectional view taken on the plane indicated by the line 7—7 of Figure 5.

Referring more in detail to the drawings, it will be noted that the reducing die forming the subject matter of this invention is indicated, generally, in the several figures of the drawings by the reference character 10. As shown particularly in Figures 4 to 7, inclusive, the reducing die 10 has an entrant end portion 11 and a delivery end portion 12 connected to the entrant end portion by means of an inwardly tapered reducing portion 13. The entrant end portion 11 of the reducing die has an internal diameter sufficient to receive one end of a length of tubular stock "A" to be reduced and the delivery end 12 has an inside diameter which corresponds to the specified outside diameter of the reduced length of tubing.

It follows from the above that the tubing delivered from the end 12 of the die has a uniform outside diameter determined by the inside diameter of the portion 12 of the die. In accordance with the present invention, the inside diameter of the reduced tubing delivered from the end 12 of the die 10 is also accurately controlled by a mandrel 14 supported within the die in concentric relation to the delivery end portion 12 of the die. The outside diameter of the mandrel 14 is predetermined to correspond to the specified inside diameter of the reduced tubing and is positioned in the die to cooperate with the delivery end portion 12 of the die to form the tubing to the proper inside and outside diameters during the drawing operation.

As shown particularly in Figure 4, the entrant end 15 of the inwardly tapered reduced portion 13 is continuous and is engageable with the end of the tubular stock "A" to impart an initial reduction to the stock. The arrangement is such that the stock is confined throughout its circumference during its initial reduction and this is advantageous in that the resulting friction heats the stock sufficiently to render the same easily workable.

As will be presently set forth, the reducing die 10 is rotated in the direction of the arrow "B" in Figure 7 during the drawing operation and as the stock continues to advance through the die, the forming pressure is relieved from successive portions of the stock. This is accomplished by forming a relief 16 in the working face of the die. The relief portion 16 extends longitudinally of the die and has an area predetermined to relieve confinement of the stock throughout a sufficient portion of its circumference to permit the stock to freely distort or deform into the relief area during the drawing operation.

In this connection, it will be noted that the longitudinal edge 17 of the relief portion 16 irons out or works the stock as successive portions of the latter distort or deform into the relief portion 16. This action of the edge 17 not only works the stock sufficiently to maintain the same in the desired plastic condition but, also, distributes the excess stock resulting from the reducing operation. If desired, the opposite edge 18 of the relief portion 16 may also be employed to work the stock and this is accomplished by projecting the edge 18 into the die cavity. The above construction is highly important in that it insures maintaining the stock in the semi-plastic state required to enable a substantial reduction to be made without subjecting the stock to the critical

stresses which tend to fracture or buckle the stock.

It may be pointed out at this time that the area of the relief portion 16, the arrangement of one or both edges 17, 18 and the extent of the continuous reducing portion 15 may all be varied to suit different types of drawing problems. For example, in some cases it may be necessary to work the stock to a greater extent during the reducing operation and this can be accomplished by projecting either or both the edges 17 and 18 of the relief portion to a greater extent into the die cavity. Moreover, the degree of heating of the stock and the extent of initial reduction thereof may be readily controlled by altering the continuous surface 15 at the entrant end of the reduced portion 13.

The reducing die 10 is journaled at opposite ends in bearings 19 carried by brackets 20 which, in turn, are secured to a bench 21 intermediate the ends of the latter. The reducing die 10 is rotated by a sprocket wheel 22 keyed to the reducing die intermediate the bearings 19 and operatively connected to a suitable prime mover 23 through the medium of a sprocket chain 24.

The mandrel 14 is secured to the rear end of a forwardly extending rod 25 having the front end engaged by a spring 26 assembled in a bracket 27 suitably secured to the front end of the bench 21. The spring 26 yieldably urges the mandrel 14 to its rearwardmost position, shown in Figure 4, and permits sufficient forward displacement of the mandrel 14 to remove the same from the die 10. When the mandrel 14 is withdrawn from the die 10, it may be swung upwardly a sufficient distance to permit a length of tubular stock on the bench 28 to be readily slipped over the mandrel. After a length of tubular stock to be reduced is slipped over the mandrel, the rear end of the stock is inserted into the entrant end 11 of the die 10 and the mandrel 14 is moved by the spring 26 to its operative position shown in Figure 4.

The forward end of the tubular stock is clamped to a slide 29 by means of a fluid-pressure operated clamp 30. As shown in Figure 3, the clamp 30 comprises cooperating sections 31 and 32 having registering semi-circular grooves in adjacent surfaces thereof adapted to receive the forward end of the stock. The section 32 is secured to the slide 29 and the section 31 is mounted on the slide 29 for movement toward and away from the section 32. The section 30 is operated by a double-acting fluid pressure motor 33 secured to the slide 29. The fluid-pressure motor 33 comprises a cylinder 34 and a piston 35 reciprocally mounted in the cylinder and connected to the section 31 of the clamp by means of the connecting rod 36.

The operation of the fluid motor 33 is controlled by a rotary valve 37 adapted to be manually operated by means of a control arm 38. When the valve is in the position thereof shown in Figure 1, fluid under pressure is admitted to the outer end of the cylinder and is exhausted from the inner end of the cylinder. As a result, the section 31 of the clamp is moved toward the section 32 to cooperate with the latter in clamping the forward end of the length of tubular stock to the slide 29. It will, of course, be understood that rotation of the valve in the opposite direction reverses the flow of fluid under pressure to the cylinder 34 and releases the clamp from the length of tubular stock.

The slide 29 is mounted on the portion of the

bench in advance of the reducing die 10 for sliding movement toward and away from the reducing die. In the present instance, the slide 29 is forceably moved toward the reducing die to extend the rear end of the tubular blank through the die by means of a fluid-pressure operated motor 39 secured to the bench 21. The fluid motor 39 comprises a cylinder 40 and a piston 41 reciprocally mounted in the cylinder. The piston 41 is provided with a plunger 42 which extends through the rear end of the cylinder and is adapted to abut the slide 29. It will also be noted from Figure 1 that the flow of fluid under pressure to the cylinder 40 is controlled by the valve 37 in such a manner that when the clamp 30 is operated to grip the forward end of the length of tubular stock, the piston 41 is moved rearwardly. Inasmuch as the piston plunger 42 abuts the slide 29, it follows that the slide is moved by the piston in a direction toward the reducing die and the extent of movement is sufficient to project the rear end of the tubular stock through the die.

As a result of the initial movement of the tubular stock by the fluid motor 39, a sufficient portion of the rear end of the stock extends beyond the adjacent end of the reducing die to enable this end to be gripped by a pulling device, designated generally in the drawings by the reference character 43. The pulling device shown herein for the purpose of illustration is of the conventional drawbench type comprising a pair of tongs 44 mounted in the usual manner on a carriage 45. The carriage 45 is, in turn, mounted on longitudinally extending tracks 46 secured to the bench 21 and is moved rearwardly with respect to the reducing die by means of an endless chain 47 suitably supported on the bench 21. The rear end of the carriage 45 is removably connected to the chain 47 by means of a lever pivotally supported intermediate the ends on the carriage and having a hook portion 48 at the rear end for engaging the chain 46. The forward end 49 of the lever is connected to the tongs in a manner to increase the gripping action of the tongs on the rear end of the tubular stock as the resistance to movement of the stock through the reducing die increases. When the carriage reaches the end of its travel, the tongs are released from the tubular stock and the carriage is returned for the next operation.

It will, of course, be understood that the slide 29 is moved with the stock as the latter is advanced through the reducing die by the carriage 45. Accordingly, it is necessary to release the length of tubular stock from the slide 29 as the forward end of the stock approaches the reducing die 10. In the present instance, the slide 29 is provided with a lateral projection 50 adapted to engage a control arm 51 on the valve 37 when the slide assumes a position adjacent the front end of the reducing die 10. Movement of the control arm 51 by the projection 50 operates the valve to release the clamp 30 and to also return the piston 41 of the fluid motor 39 to its inoperative position.

Operation

Assuming that it is desired to draw one of the lengths of tubular stock on the bench 28, the operator merely moves the mandrel 14 in a forward direction against the action of the spring 26 and swings the mandrel upwardly to a position wherein one of the lengths of tubular stock may be slipped over the mandrel. The rear end of

the length of tubular stock is then positioned in the entrant portion 11 of the reducing die and the forward end of the tubular stock is positioned between the cooperating sections of the clamp 30. During this time, the spring 26 moves the mandrel 14 rearwardly to its operative position in the reducing die.

The valve 37 is then operated to clamp the forward end of the stock to the slide 29 to move the slide rearwardly a sufficient distance to project the rear end of the stock through the reducing die 10. As soon as the rear end of the stock is projected beyond the adjacent end of the reducing die, it is gripped by the tongs 44 on the carriage 45 and is pulled through the die by movement of the carriage rearwardly on the bench 21. As the forward end of the tubular stock approaches the reducing die, the valve is again operated by the projection 50 on the slide 29 to open the clamp 30 and to return the piston 41 in the fluid motor 39 to its inoperative position.

It will, of course, be understood that the reducing die is continuously rotated during the drawing operation and that the continuous surface 15 at the entrant end of the tapered reducing portion of the die performs the initial reducing operation. Inasmuch as this surface confines the stock throughout its circumference, it will be noted that considerable friction results and this is advantageous in that it raises the temperature of the cold stock sufficiently to render the same easily workable. As the stock continues to move through the reducing die, the relief portion 16 relieves the confinement of the stock through a sufficient portion of its circumference to permit relatively free distortion of the stock into the relief portion. As a result, the stock is thoroughly worked and maintained in a plastic condition by one or both edges 17, 18 of the relief portion 16. This is advantageous because it facilitates reducing the stock during the drawing operation and avoids stressing the stock to the point where it will fracture or buckle.

What I claim as my invention is:

1. In apparatus for reducing and cold drawing a length of tubular stock, a revoluble reducing die comprising an entrant end portion adapted to receive one end of a length of tubular stock to be reduced and a reduced delivery end connected to the entrant end through the medium of a tapered reducing portion, said tapered reducing portion having a continuous circumferential surface adjacent the entrant end of the die for initially confining the stock throughout its circumference to heat the stock and having a relief portion extending from the continuous surface toward the delivery end of sufficient width to permit distortion of the stock during the reducing operation, means for advancing a length of tubular stock to be reduced through said die, and means for rotating the die during the time the stock is advanced through said die.

2. In apparatus for reducing and drawing tubing, a revoluble reducing tool having an entrant end portion adapted to receive one end of a length of tubular stock and having an axially extending cavity at least a portion of which is of progressively diminishing cross section longitudinally of the tool from the entrant end portion thereof, the wall of said cavity being adapted to engage and reduce the stock upon rotation of the tool and upon axial movement of the stock through the tool, said tool being provided with a relief recess extending longitudinally substantially throughout the length of said cavity, the

area of the stock engaging wall of the cavity being substantially greater than the area of the relief recess to enable a major portion of the circumference of the stock to be engaged by the tool during the reducing operation leaving the remaining portion free to deform into the relief recess in response to the reducing operation, means for advancing a length of tubular stock through the reducing tool, and means for rotating the tool as the tubular stock is moved through the same.

3. In apparatus for reducing and drawing tubing, a revoluble reducing tool comprising an entrant end portion adapted to receive one end of a length of tubular stock and having an axially extending cavity at least a portion of which is of progressively diminishing cross section longitudinally of the tool from the entrant end of said tool, the wall of said cavity being adapted to engage and reduce the stock upon rotation of the tool and upon axial movement of the stock through the tool, said wall being provided with a relief recess extending longitudinally substantially throughout the length of said cavity, the area of the stock engaging wall of the cavity being substantially greater than the area of the relief recess to enable a major portion of the circumference of the stock to be engaged by the tool during the reducing operation leaving the remaining portion free to deform into the relief recess in response to the reducing operation, a mandrel having a diameter less than the diameter of the delivery end portion of the tool and supported in the latter end portion in concentric relation thereto, means for advancing a length of tubular stock through the reducing tool over said mandrel, and means for rotating the tool as the stock is advanced through the cavity.

4. In apparatus for reducing and drawing tubing, a revoluble reducing tool comprising an entrant end portion adapted to receive one end of a length of tubular stock and having an axially extending cavity at least a portion of which is of progressively diminishing cross section longitudinally of the tool from the entrant end of said tool, the wall of said cavity being adapted to engage and reduce the stock upon rotation of the tool and upon axial movement of the stock through the tool, said wall being provided with a relief recess extending longitudinally substantially throughout the length of said cavity, the area of the stock engaging wall of the cavity being substantially greater than the area of the relief recess to enable a major portion of the circumference of the stock to be engaged by the tool during the reducing operation leaving the remaining portion free to deform into the relief recess in response to the reducing operation, one of the edges defining the juncture of the cavity wall and the relief recess being shaped to work the stock during the reducing operation, means for advancing a length of tubular stock through the reducing tool, and means for rotating the tool as the stock is advanced through the tool cavity.

5. In apparatus for reducing and cold drawing a length of tubular stock, a revoluble reducing die having an entrant end portion for receiving one end of a length of tubular stock and having a continuous annular portion adjacent the entrant end portion for engaging the stock throughout its circumference to partially reduce and heat the stock upon rotation of the tool and upon axial movement of the stock through the tool, a second reducing portion having an axial-

ly extending cavity at least a portion of which is of progressively diminishing cross section longitudinally of the tool, the wall of said cavity being adapted to engage and reduce the stock, said wall being provided with a relief recess extending longitudinally substantially throughout the length of the cavity, the area of the stock engaging wall of the cavity being substantially greater than the area of the relief recess whereby a major portion of the circumference of the stock is engaged by the tool during the reducing operation leaving the remaining portion free to deform into the relief recess in response to the reducing operation, means for advancing a length of tubular stock through the tool, and means for rotating the tool as the stock is advanced through the cavity.

6. The method of drawing and reducing a length of tubular stock which comprises advancing a length of tubular stock through a revoluble reducing tool, exerting a reducing pressure on a continuous area extending over a major portion of the circumference of the stock by the reducing tool while leaving the remaining portion free to deform in response to the reducing pressure, and rotating the reducing tool as the stock is moved through the latter to enable circumferentially progressive deformation longitudinally of the tool in the area out of contact with the pressure exerting means.

7. The method of drawing and reducing a length of tubular stock which comprises advancing a length of tubular stock through a revoluble reducing tool, initially circumferentially confining the stock continuously around the entire circumference thereof by the reducing tool to heat the stock to permit subsequent control of the flow of the stock, and while the stock is so heated confining the stock on a continuous area extending over a major portion of its circumference sufficient to conform the exterior of the stock to the shape of the reducing tool while relieving the confinement of the stock for a predetermined area longitudinally of the tool to thereby permit distortion of longitudinal portions of the stock into the relief area during the reducing operation, and controlling the flow of the stock by the confining and relief areas of the tool.

8. The method of drawing and reducing a length of tubular stock which comprises progressively heating and partially reducing the stock by exerting a reducing pressure continuously around the entire circumference of the stock, immediately further reducing the stock and working the material thereof by exerting a reducing pressure on a continuous area extending over a major portion of the circumference of the stock while leaving the remaining portion free to deform in response to the reducing pressure, and simultaneously rotating the pressure exerting means and feeding the stock axially relative to said means to permit circumferentially progressive deformation longitudinally of the stock.

9. The method of drawing and reducing tubular stock which comprises advancing a length of said tubular stock through a revoluble reducing tool, exerting a concave arcuate confining and progressively reducing pressure upon the circumference of the stock on opposite sides of the center of said tool while leaving a segment of said circumference less than the diameter of the stock free to deform in response to and in slight relief of said pressure, and in relatively rotating said reducing tool as the stock is moved

therethrough thereby permitting circumferentially progressive deformation longitudinally of the stock in the area out of contact with said pressure confining and reducing means.

10. In apparatus for reducing and drawing tubing, a revoluble reducing tool having an entrant end portion adapted to receive one end of a length of tubular stock and having an axially extending cavity at least a portion of which is of progressively diminishing cross section longitudinally of the tool from the entrant end portion thereof, the concave surface of the wall of said cavity being adapted to engage, confine and reduce the stock upon relative rotation and axial movement towards one another of the stock and tool, said wall being provided with a relief

recess extending longitudinally substantially throughout the length of the cavity, said recess being of a width less than the diameter of the stock at each stage of reduction of the latter whereby a substantial portion of the circumference of the stock on opposite sides of the center thereof is engaged and confined by said tool during the reducing operation leaving a portion free to deform into said relief recess in response to and in slight relief of the reducing pressure, means for advancing said length of tubular stock through said reducing tool, and means for relatively rotating said tool and tubular stock as the latter is moved through the former.

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