Dec. 13, 1955 W. P. HILL 2,726,561

APPARATUS FOR SHAPING TUBULAR STOCK

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FIG. 2

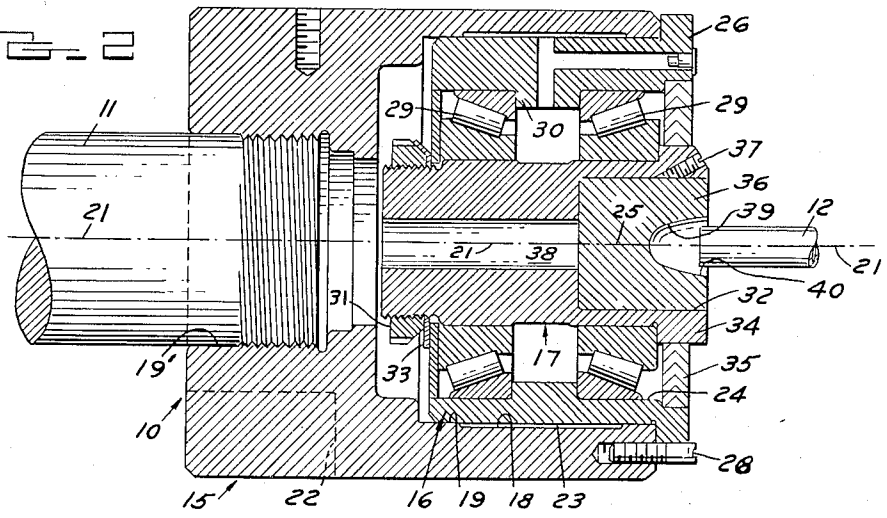


FIG. 3

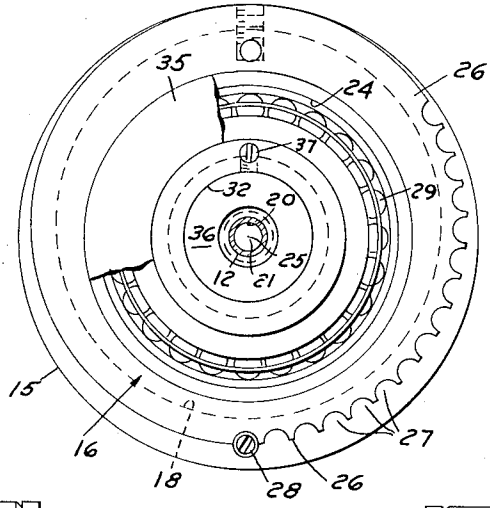
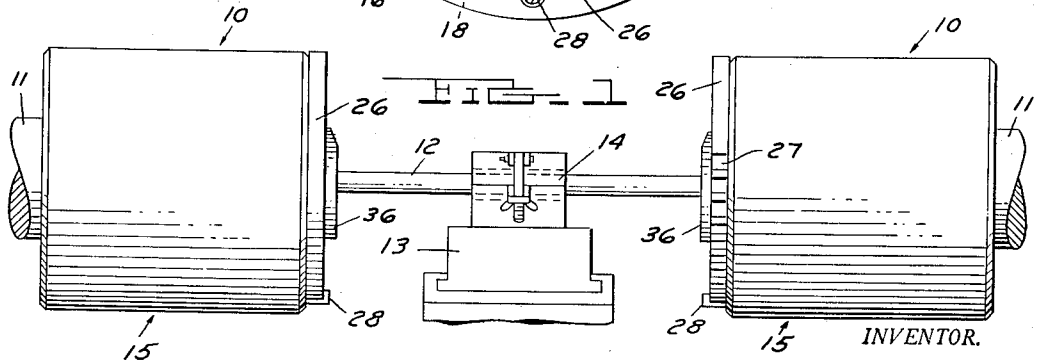


FIG. 1



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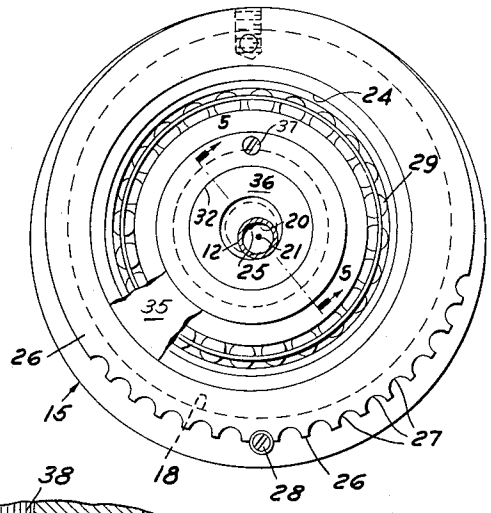


FIG. 4

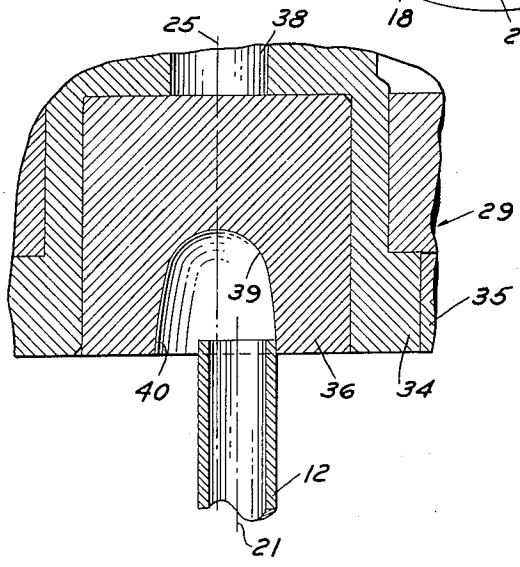


FIG. 5

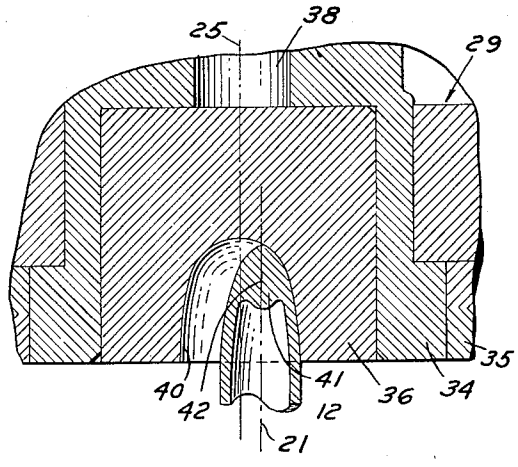


FIG. 6

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APPARATUS FOR SHAPING TUBULAR STOCK

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Application March 19, 1951, Serial No. 216,421

5 Claims. (Cl. 78—89)

This invention relates generally to an improved apparatus for shaping stock to conform the latter to the contour of a part of a tool.

It is an object of this invention to provide an apparatus rendering it possible to deform workable stock to a substantial degree without the danger of overheating or appreciably altering the preferred characteristics of the stock.

One instance where this invention finds particular utility is in the manufacture of casings, containers, or tubes having one or both ends closed or partially closed. The present invention enables producing such products from tubular stock of workable material by reducing one or both ends of the stock to the desired degree, and accomplishes this result regardless of whether the stock is of a ferrous metal such as steel and alloys of steel, or is of a nonferrous metal, such for example, as copper, copper alloys, aluminum or similar materials.

With the above in view, it is another object of this invention to reduce one or both ends of a length of tubular stock by exerting a rolling pressure on successive circumferentially extending portions of the stock of limited area, while leaving the portions of the stock out of contact with the pressure applying means free to deform in response to the rolling pressure. Although the stock out of direct contact with the pressure applying means is free to deform during the rolling operation, nevertheless, the tool is of a nature to confine the stock so that the latter is effectively reduced. Also with the above arrangement, the area of the stock subjected at any one time to the rolling-reducing pressure is restricted; and in the event the stock to be reduced is still or some similar metal, this area is preferably very small, so that substantial deformation of the stock may be accomplished without damaging or overheating the stock. The area of contact of the pressure applying means with the stock may be increased somewhat in cases where more ductile metals are used; but even when such metals are to be reduced, it is preferred to restrict the area of the stock contacted at any one time by the pressure applying means in order to obtain proper distribution of the stock.

It is still another object of this invention to initially exert a circumferential rolling pressure in a generally radially inward direction on limited areas of the stock extending around the circumference of the stock, and finally exerting the rolling pressure in a generally axially extending direction to close the end of the stock.

It is a further object of this invention to provide stock reducing apparatus having a reducing tool freely rotatably supported about an axis offset laterally from the axis of the tubular stock to be reduced, and having an eccentric mounting for the tool adjustable to vary the degree of eccentricity between the axis of the stock and the axis of the tool. Thus tubular stock of different diameters may be reduced by the tool, and the reducing

pressure or the area of the stock contacted at any one time by the tool may be varied.

It is a still further object of this invention to provide a reducing tool of the above type having a cavity concentric with the tool axis for receiving one end of the stock and having at least a portion of the cavity progressively decreasing in cross sectional area axially of the tool. Thus the tool is actually in the form of an internal roll which not only has a rolling contact with limited areas of the stock, but in addition, confines the stock in order to effectively reduce the latter.

It is a still further object of this invention to provide an apparatus of the above general type wherein the tool life is appreciably increased even though the reducing tool is formed of an inexpensive mild steel, and even though the stock to be reduced is formed of steel or some equally difficult material to shape. In working steel or steel alloys, the metal is preferably heated to a temperature where oxides are formed on the surface of the stock. Such heating not only renders the stock more workable, but in addition, enables the oxide to impregnate the rolling surface of the tool and greatly improve the wearing qualities of the tool.

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

Figure 1 is a semidiagrammatic side elevational view of reducing apparatus forming the subject matter of this invention;

Figure 2 is a sectional view of one of the reducing heads of the apparatus, the axis of the tool holder being shown in its zero position, i. e. coinciding with the axis of rotation of the head;

Figure 3 is an end elevational view of the reducing head shown in Figure 2;

Figure 4 is a semidiagrammatic view showing the relationship between the stock and reducing tool in the head;

Figure 5 is a semidiagrammatic sectional view taken on the line 5—5 of Figure 4; and

Figure 6 is a view similar to Figure 5 showing the completion of the reducing operation.

The method and apparatus about to be described may be used to advantage for shaping stock to various different contours regardless of whether the stock is of ferrous metal such as steel or is of a more ductile metal such as copper, copper alloy or aluminum. However the present invention is especially applicable when employed for reducing one or both ends of a length of tubular stock to form casings, containers, or other tubular products, such for example, as primer tubes. Accordingly the apparatus selected herein for the purpose of illustration is of the type found especially satisfactory for reducing either or both ends of a length of tubular stock.

It will further be understood as this description proceeds that the present invention renders it possible to completely close either or both ends of the tubular stock and is capable of effectively accomplishing this result in connection with relatively large diameter stock formed of steel, steel alloys, copper, copper alloys, aluminum or similar relatively ductile metals. Tubular stock of ferrous metals, such for example, as steel is particularly difficult to reduce, especially where the extent of reduction must be sufficient to completely close one or both ends of the stock. In accordance with this invention one or both ends of a length of tubular stock may be completely closed in a relatively short interval of time and with a minimum amount of wear of the tools by exerting a rolling pressure on successive circumferentially extend-

ing portions of limited area of the stock. Thus only a relatively small area of the stock is subjected to the rolling reducing pressure at any one time, and the remainder of the stock is free to deform in response to the rolling pressure. In instances where the stock is formed of steel or steel alloys, it is preferred to preheat the portions of the stock to be reduced prior to subjecting the stock to the rolling pressure. The temperature to which the steel or steel alloy stock is preheated depends to some extent on the characteristics of the stock; but in any case, is heated to a temperature sufficiently high to cause oxide to form on the outer surface of the stock and to render the stock workable under the prevailing rolling pressures. The advantage of forming an oxide on the outer surface of the stock prior to introducing the stock into the tool will be more fully hereinafter explained. Briefly this oxide becomes embedded in the adjacent wall of the tool, and provides a hard wear resisting surface on the tool even though the latter may be formed of a mild cold-rolled steel, for example. In instances where the stock is of a ductile metal, such for example, as copper or copper alloy, it is possible to satisfactorily reduce a length of tubular stock to completely close one or both ends without preheating the stock.

With the above in view reference is now made more in detail to the drawings, wherein Figure 1 diagrammatically illustrates one type of apparatus found highly satisfactory for reducing one or both ends of a length of tubular stock, regardless of whether the latter is formed of ferrous or nonferrous metals. The apparatus comprises a pair of axially aligned reducing heads **10** spaced from each other in the direction of their axes and respectively secured to suitable drive shafts **11**. The drive shafts **11** are driven by a suitable prime mover, and are supported for relative axial movement to enable the heads **10** to be fed toward and away from one another. The means for rotating the drive shafts **11** and for feeding the same in the direction of their axes are not shown herein, as this mechanism forms no part of the present invention.

The numeral **12** indicates a length of tubular stock which may be of a ferrous metal such as steel or of a nonferrous metal such for example as copper, copper alloy or other ductile metals. In any case the length of stock **12** is shown diagrammatically in Figure 1 as supported intermediate the ends on a carriage **13** and as secured against rotation by a clamp **14** on the carriage. The carriage **13** is movable in a direction perpendicular to the axes of rotation of the reducing heads **10**, and the means for operating the same is not shown herein. It will suffice to point out that the length of stock is mounted on the carriage **13** in a manner to enable the stock to be positioned between the reducing heads **10** in axial alignment with the latter.

The reducing heads **10** are identical in construction and a description of one will suffice for both. As shown in Figures 2 and 3 of the drawings, each head comprises a housing **15**, a carrier **16** and a tool holder **17**. The housing **15** has a recess **18** formed in the inner end and has a bore **19'** extending axially of the head from the base of the recess to the outer end of the housing. The bore **19'** is fashioned to receive the inner end of the adjacent drive shaft **11** and is internally threaded for attachment to the drive shaft **11**. The recess **18** has a bearing **19** concentric with an axis **20** offset laterally with respect to the axis **21** about which the head **10** rotates and on which the length of tubular stock **12** is supported during the reducing operation. Thus the bearing **19** is eccentrically located with respect to the axis of rotation of the head, and the purpose of such an arrangement will become apparent as this description proceeds. In order to compensate for the eccentricity of the bearing **19** relative to the axis **21** of rotation of the head, a portion of the housing **15** is cut away at the outer end as at **22** in Figure 2.

The carrier **16** is in the form of a sleeve having a cylindrical part **23** journalled in the bearing **19** and having a bore **24** eccentrically located with respect to the bearing **19** or cylindrical part **23**. The axis of the bore **24** is indicated in Figure 4 of the drawings by the reference character **25**, and the relationship between the several axes is such that the axis **25** of the carrier may be moved from a position in coaxial relationship to the axis **21** of rotation of the head **10** (Figure 3) to any one of several selected positions which are laterally offset different degrees from the axis **21**.

In Figure 3 of the drawings the axis **25** of the carrier **16** is shown in its zero position; or in other words, coincides with the axis **21** of rotation of the head **10**. In use however the axis **25** of the carrier **16** is offset laterally with respect to the axis **21**, and this is accomplished by merely rotating the carrier relative to the housing on the bearing **19**. In this connection it will be noted that the carrier has a radially outwardly extending flange **26** at the inner end, and this flange abuts the inner end of the housing **15**. It will be noted from Figure 3 of the drawings that the flange **26** is formed with a plurality of circumferentially spaced notches **27**, and these notches are selectively engaged by a pin **28** in the form of a stud secured to the inner end of the housing **15**. It follows therefore that the carrier **16** is normally secured to the housing by the pin **28** and rotates as a unit with the housing about the axis **21**. It also follows that the carrier **16** may be secured to the housing in any one of a number of different angular positions with respect to the housing so that different degrees of eccentricity of the axis **25** relative to the axis **21** may be obtained.

The tool holder **17** is in the form of a shaft journalled in bearings **29**, which in turn, are respectively secured in the bore **24** of the carrier **16**. The bearings **29** are spaced axially from each other by an annular shoulder **30** extending radially inwardly from the carrier intremediate the ends of the latter.

The outer end of the tool holder is threaded for receiving a lock nut **31**, and the inner end of the tool holder has a recess **32** therein. The lock nut **31** cooperates with a suitable lock washer **33** to prevent inward displacement of the holder **17** relative to the carrier and outward displacement of the holder is prevented by an enlargement **34** positioned on the holder to engage the inner bearing **29**. A suitable oil seal **35** is secured in the inner end of the bore **24** in the carrier **16** to close the space around the tool holder **17**.

Attention is called to the fact that the bearings **29** support the tool holder **17** for free rotation about the axis **25** of the carrier **16**. It is important to note that the tool holder **17** is not directly driven, but on the other hand, may rotate freely relative to both the housing **15** and the carrier **16**. It will also be noted that since the tool holder **17** has the same axis **25** as the carrier **16**, it is angularly adjusted relative to the housing **15** as a unit with the carrier **16** to vary the degree of eccentricity of the tool holder relative to the axis **21** of rotation of the head **10**.

Removably secured within the recess **32** at the inner end of the tool holder **17** is a reducing tool **36**. The reducing tool is removably held in the recess by a set screw **37** threaded in the enlargement **34** of the tool holder **17**. A bore **38** extends axially of the tool holder from the base of the recess **32** to the outer end of the tool holder, and is adapted to receive a knock-out tool when it is desired to remove the reducing tool **36** from the recess **32**.

The reducing tool **36** is in the form of a block of metal having a cavity **39** in the inner end thereof. The cavity **39** has a straight cylindrical section **40** at the entrant end which is concentric to the axis **25** of rotation of the tool holder; and progressively decreases in cross section from

the cylindrical part 40 to the axis 25, as clearly shown in Figure 5 of the drawings.

In use the carrier 16 is angularly adjusted relative to the housing 15 to locate the axis 25 of the tool holder 17 in offset relationship to the axis 21 of rotation of the head 10 (see Figures 4–6). Since the length of tubular stock 12 is supported in coaxial relationship to the axis 21, it will be noted that only a limited area of one side of the stock is engaged by the wall of the cavity 39, as clearly shown in Figure 5 of the drawings. As pointed out above the length of stock 12 is secured against rotation on the carriage 13 by the clamp 14 so that rotation of the head 10 results in a frictional engagement between the stock and wall 39 of the cavity. This frictional contact imparts rotation to the tool holder 17 and the wall of the cavity 39 has a rolling engagement with limited areas of the stock extending circumferentially of the latter.

Where both ends of a length of tubular stock 12 are to be reduced, the stock and heads 10 are relatively positioned on the axis 21, and the heads 10 are fed toward one another to project the opposite ends of the stock into the respective tool cavities 39, as indicated in Figure 5, of the drawings. The heads 10 are then fed in directions toward one another, and at the same time, are rotated. Although the axis of the tool 36, indicated at 25, is offset or eccentric with respect to axis 21 of the head, it is readily apparent that tool holder 17 will be caused to revolve about axis 21 of the head as the latter rotates. When the head 10 is advanced sufficiently to cause wall 39 of the tool civity to engage the stock, it is apparent that the rotation of the head together with the fricional engagement between the tool cavity and stock causes a rotation of tool holder 17 about its own axis, whereby cavity 39 has a continuous rolling engagement with the stock about successive limited areas extending circumferentially thereof. This can be more clearly understood by referring to Figures 4–6. Thus, for example, when the head is rotated 180 degrees so that the axis 25 of the tool lies on the opposite side of axis 21 (see Figure 4), it will be apparent that the cavity 39 of the tool will engage the stock at a limited circumferential area diametrically opposite to that subjected to the action of the tool cavity shown in Figure 4. During initial relative movement of the heads 10 toward one another, the reducing tools 36 exert a rolling pressure in a generally radially inward direction on the stock to progressively reduce the diameter of the latter, and finally exert a rolling pressure in a generally axial direction on the stock to completely close the ends of the stock. If desired the axial rolling pressure may be continued after the ends are closed in order to in effect upset the metal at the ends of the stock as indicated by the reference numeral 41 in Figure 6 of the drawings. The line 42 at the end of the stock indicates the joint which results when the metal at the end or ends of the stock are brought together. Since the reducing pressure is applied successively to only limited circumferentially extending areas of the stock, the remaining areas being out of contact with the tool, the temperature of the stock is maintained well below any temperature which might injure the stock or cause a welding together of the metal at joint 42. Therefore, in practice, although the metal is intimately joined at the closed end or ends of the stock, the joint 42 nevertheless remains, although not readily apparent. It will, of course, be understood that the rolling-reducing pressure may be discontinued prior to completely closing the ends of the stock if it is desired to leave restricted openings at the ends of the stock.

It is important to note that during the reduction of the stock, the wall of the cavity 39 freely rotates around the stock, and the reducing pressure is successively applied to limited areas extending circumferentially of the stock. Thus the remaining portions of the stock, or in other words, the portions of the stock out of contact with the reducing tool, are free to deform in response to the rolling pressure. This arrangement affords a more uniform control of the flow of the metal during the reducing operation, and maintains the temperature of the stock well below any temperature that may injure the stock. It is also important to note, however, that while the metal out of direct contact with the wall of the cavity 39 is free to deform, nevertheless, the stock is confined by the cavity 39; and as a result, is effectively contracted or reduced during the rolling operation.

It will further be noted that the stock need not be heated by an external source during the reducing operation. Practically the only heating obtained during the reducing operation results from the friction, and since this friction is somewhat reduced during the final stages of the reducing operation, it follows that the stock is cooled to some extent. However when reducing ferrous metals, such for example as steels, it is preferred to preheat the ends of the stock prior to subjecting the latter to the reducing operation. The temperature to which the stock is preheated depends largely on the nature of the stock; but in any case, preheating is effected to such a temperature that the stock is not only rendered more readily workable by the rolling pressures to be applied, but also to a temperature high enough to provide a coating of oxide on the surface of the stock. In practice this oxide flakes off and becomes lodged in the wall of the cavity 39 during the rolling operation. This is especially true in cases where the tool is formed of a relatively mild cold rolled steel, for example; and provides a wear resisting surface on the tool or wall of the cavity 39. When reducing stock of copper, copper alloys or similar ductile materials, it is not essential to preheat the stock, as the heat normally generated during the reducing operation is sufficient to render such materials workable.

What I claim as my invention is:

1. Apparatus for reducing stock comprising a head rotatable about a first axis, a carrier rotatable as a unit with said head and having a cylindrical bearing, a reducing tool mounted in said bearing for free rotation about the axis of said bearing and having a stock receiving cavity concentric with said bearing, at least a portion of said cavity progressively diminishing in cross-section axially of said tool and the wall of said cavity being adapted for rolling contact with the stock to be reduced, and means for mounting said carrier on said head in different positions of transverse adjustment with the axis of said bearing generally parallel to the axis of rotation of said head, whereby to locate said bearing in various positions laterally offset from the axis of rotation of said head.

2. The apparatus defined in claim 1, in which said last-named means includes a bearing on said head mounting said carrier for rotation about a third axis laterally offset from the first and second axes.

3. The apparatus defined in claim 2 in which the third axis is so located with respect to the first and second axes that rotation of the carrier about the third axis relative to the housing varies the degree of eccentricity between the first and second axes from zero to a predetermined maximum.

4. Apparatus for reducing stock comprising a head having a housing rotatable about a first axis and having an eccentric cylindrical bearing in said housing, means for rotating said housing, a carrier rotatable as a unit with said housing and having a peripheral bearing surface journalled in the eccentric housing bearing, said carrier having an eccentric cylindrical bearing, and a reducing tool journalled in the last-named cylindrical bearing for free rotation and having a cavity concentric with said last-named cylindrical bearing for receiving one end of a length of stock to be reduced, at least a portion of said cavity progressively diminishing in cross-section axially of said reducing tool and the wall of said cavity being adapted for rolling contact with the length of stock, and

means for locking said carrier to said housing in different positions of rotative adjustment.

5. The apparatus defined in claim 4 in which the entrant end of said cavity embraces said first axis.

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