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MANUFACTURE OF FLANGED TUBES

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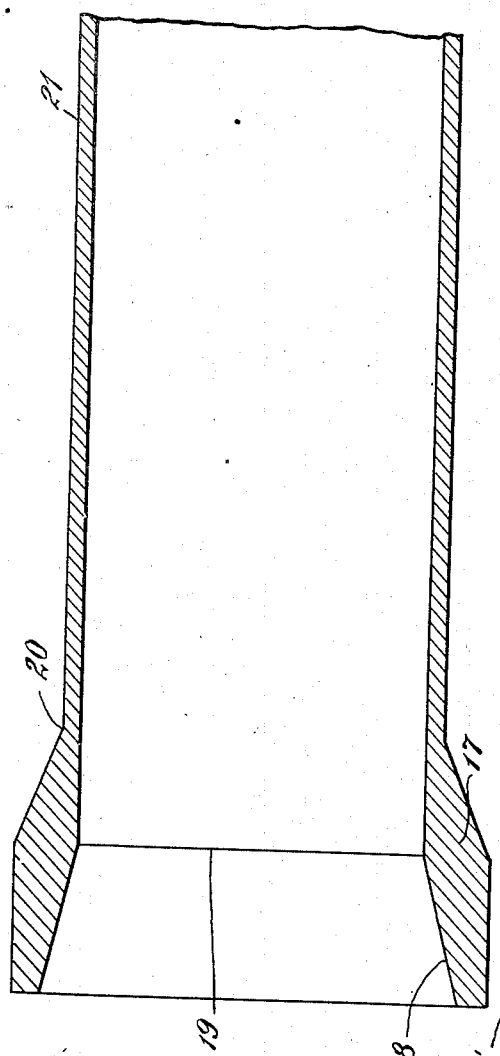

Fig. 1.

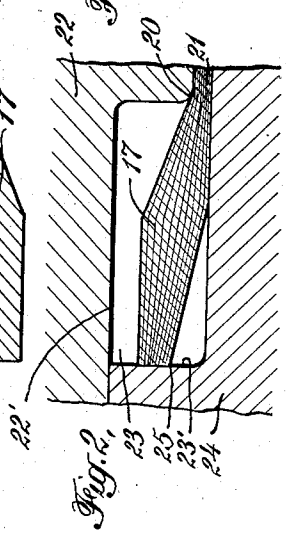

Fig. 2.

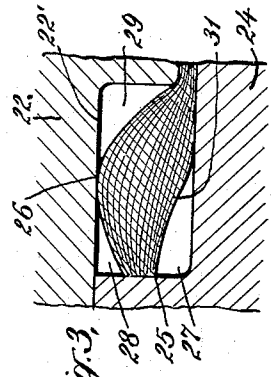

Fig. 3.

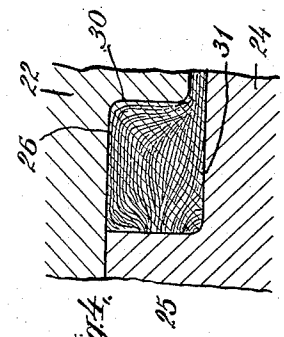

Fig. 4.

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MANUFACTURE OF FLANGED TUBES

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4 Claims. (Cl. 29—156)

This invention relates to the manufacture of flanged, metal tubes and has particular reference to a novel method of upsetting the metal near one end of a tube to form an integral flange on the tube. The new method is economical in practice, and by its use the tube may be upset or shortened to a greater extent in a single operation than in prior methods, without resulting in cold shuts or other imperfections in the metal.

In the manufacture of flanged tubes, such as torque tubes, axles, etc., a metal tube is subjected at one end to a series of forgings or upsetting operations wherein a quantity of metal is gathered to thicken the end of the tube and thereby provide the metal for the flange. According to common practice, the tube is initially thickened at one end over a predetermined length to form an external shoulder at a selected distance from the end. The tube, heated to a forging temperature, is then placed in a die against which the shoulder is seated, and a punch which fits closely in the tube is forced inwardly with a shoulder on the punch engaging the end of the tube, whereby the thickened portion of the tube is shortened and made still thicker. This upsetting operation is repeated so as to shorten the thickened portion progressively until it is built up to the desired external diameter.

The upsetting of metal tubes as practiced heretofore has not produced satisfactory results when the amount of upset in any single operation is greater than about 60%, that is, when the length of the thickened portion prior to the upsetting operation is over 60% greater than its length after the operation. More particularly, when upsets in excess of 60% are performed according to conventional practice, the thickened portion of the tube tends to buckle outwardly under the force of the punch, with the result that relatively cold surfaces of the thickened portion in the region of buckling are forced into contact with each other and cause cold shuts which weaken the flange. To avoid these cold shuts, each upsetting operation is limited to an upset of approximately 60% or less, and, accordingly, the formation of the flange in many instances requires a considerable number of upsetting operations which involve an appreciable item of expense.

One feature of the present invention, therefore, resides in the provision of a novel method of forming a flange on a metal tube, by the practice of which an upset substantially in excess of 60% may be obtained in a single operation without causing imperfections in the metal, such as cold shuts. In addition, the new method is simple in application and results in a controlled flow of the metal during the upsetting operation so as to provide on the tube an integral flange which is strong and durable.

According to the new method, the tube is initially thickened at one end in any suitable manner, as by means of a series of upsetting operations wherein metal is progressively gathered from one end of the tube. The thickened end of the tube is then expanded, preferably to an extent such that the socket formed by the expanding operation has an internal diameter at least as great as the external diameter of the main body of the tube. This expansion of the tube may be conveniently effected by forcing a punch into the end of the tube while the latter is at a high temperature. Preferably, the tube is expanded from the end thereof inwardly for a distance at least half the length of the thickened portion, and the latter is of a length which is equal to or less than the external diameter of the main body of the tube. The thickened and expanded portion of the tube is then confined in a space with a clearance around the outside of this portion, and while it is at a forging temperature it is subjected to a compressive force generally parallel to the tube which moves the metal at the end of the tube rearwardly without appreciable buckling and thereby causes metal to flow in a controlled manner into the clearance to build up the flange.

With this method, an upset of 100% may be obtained in a single operation without producing cold shuts. In gathering and expanding the metal at one end of the tube prior to the main upsetting operation, a thickened portion is formed having its greater thickness intermediate its ends so that it effectively resists any substantial buckling during the main upsetting operation. Also, due to the formation of the socket, the internal diameter of the end of the tube is substantially greater than the internal diameter of the main body of the tube before the main upset occurs, and as a result, when the thickened end of the tube is subjected to the compressive force in the main upsetting operation, the forces tending to buckle the thickened portion are comparatively small. Thus, the flow of metal in the formation of the flange is controlled so as to reduce the forces tending to buckle the thickened portion and provide the greatest resistance to buckling in the region where buckling normally occurs.

For a better understanding of the invention,

reference may be had to the following detailed description taken in conjunction with the accompanying drawing, in which

Fig. 1 is a longitudinal, sectional view of one end of a metal tube as it appears subsequent to the preliminary upsetting and expanding operations but prior to the main upsetting operation, and

Figs. 2, 3 and 4 are longitudinal, sectional views of part of the thickened portion of the tube illustrating different stages of the main upsetting operation wherein an upset of approximately 100% is obtained.

In the practice of the new method, the tube is subjected to preliminary upsetting operations which gather metal from one end of the tube and consequently thicken the tube, as shown at 17 in Fig. 1. However, prior to the main upsetting operation, the thickened part of the tube is expanded to form a socket 18. According to the preferred method, the thickened part 17 is expanded from the end of the tube inwardly to a point 19 which is at least half the distance to the inner end 20 of the thickened part, and the latter is made of a length equal to or less than the external diameter of the main body 21 of the tube. The socket 18 may be formed in the same operation by which the metal is gathered to form the thickened part 17 or it may be formed by inserting a punch in the end of the tube after the metal has been gathered in the preliminary operations. In either case, the thickened end 17 is preferably expanded so that the internal diameter of the end of the tube is equal to or greater than the external diameter of the main body 21. The socket 18 could be formed with its major wall parallel to the axis of the tube, but, as shown, it is of gradually increasing diameter from its inner end 19 to the outer end of the tube. The initial upsetting and expanding operations are preferably correlated so that the thickened part 17 prior to the main upestting operation to be described has an external radius which exceeds the corresponding radius of the main body 21 by at least the thickness of the main body. Also, I prefer to form the thickened part 17 in such a manner that it gradually increases in external diameter from its inner end 20 to a point substantially in radial alignment with the inner end 19 of the socket.

The tube in the form shown in Fig. 1 is placed in a die 22 which provides a substantial clearance 23 around the outside of the thickened portion, as shown in Fig. 2. The tube is secured against longitudinal movement in the die and, while at a forging temperature, is subjected to a compressive blow by a punch 24 which fits closely in the tube and is formed with a shoulder 25 which strikes the end of the tube. As the thickened part 17 shortens under the action of the punch, metal is displaced into the clearance 23 so as to increase the external diameter of the thickened portion. Since the portion 25 of the inner wall of the socket near the end of the tube is disposed outwardly at least as far as the outer wall of the main body 21, the compressive force tending to buckle the thickened part 17 is off-set outwardly from the inner end 20 of the thickened portion so that it is less effective as a buckling force, and there is a tendency for the metal above an imaginary line between points 20 and 25 to slide back over the metal below this imaginary line, as shown in Fig. 3. Also, since the part 17 is thickest intermediate its ends, it offers the greatest resistance to buckling at the region where buckling would normally occur. While the part 17 may buckle a slight amount, as illustrated in Fig. 3, previous expansion of the end of the tube in forming the socket 18 causes the outer wall of the thickened portion to lie considerably closer to the inner wall 22' of the die than would otherwise be the case, and, as a result, this inner wall limits the buckling to a negligible amount. When the upsetting proceeds to the stage where the thickened portion engages the outer wall 22' of the clearance space, as shown at 26 in Fig. 3, continued movement of the punch causes metal to flow inwardly into the space 27 in the socket and outwardly into the space 28 outside the socket and also forces metal back into the corner 29 of the clearance space, to form the flange 30.

Since the part of the thickened portion 17 which is first contacted by the punch is chilled and sticks to the punch, it maintains the same radial position throughout the upsetting operation. The relatively thick, intermediate portion of the part 17 tends to resist expansion more effectively than the end portions of this part which are thinner and therefore more thoroughly heated and at a higher temperature. Accordingly, while the intermediate portion of the part 17 is buckling slightly, upsetting or thickening of the stock near the ends of the part 17 is occurring so as to fill the corners of the clearance space. It will be observed that after the intermediate portion 26 of the part 17 first contacts the wall 22' of the clearance space, this intermediate portion is moved back parallel to the axis of the tube to a position near the rear end of the thickened part, as shown in Fig. 4. Also, during the slight buckling of the part 17, the intermediate portion 31 thereof adjacent the punch is moved a short distance outwardly, but after the part 26 contacts the outer wall 22' of the clearance space, further expansion of the metal by the punch depresses the portion 31 and causes it to reengage the punch. Thus, the metal is caused to flow in a controlled manner such that the corners of the clearance space are filled without any appreciable buckling of the thickened part 17.

By the practice of the new method, upsets as high as 100% may be obtained in a single operation with entirely satisfactory results. In many instances, therefore, at least one upsetting operation may be saved over the number of operations required in the conventional practice wherein each upset is relatively small. Since the flange formed by the new method is free of cold shuts and similar imperfections, it has all the strength and durability of similarly shaped flanges formed in accordance with the more expensive conventional practice requiring a greater number of upsetting operations.

I claim:

1. A method of forming a flange on a metal tube, which comprises gathering metal from one end of the tube to form a thickened portion gradually increasing in thickness from the inner end thereof to a point intermediate its ends, expanding the thickened portion to form a socket gradually decreasing in internal diameter from the outer end of said thickened portion to a point intermediate the ends thereof, confining the expanded portion within a space with a substantial clearance around the outside of said portion whereby a substantial length of the socket wall is unsupported around the outside, and buckling the intermediate part of the expanded portion radially outwardly against the wall of said clear-

ance by subjecting the outer end of the expanded portion to axial compression while securing said end against radial movement.

2. A method of forming a flange on a metal tube, which comprises gathering metal from one end of the tube to form a thickened portion gradually increasing in thickness from the inner end thereof to a point intermediate its ends, expanding the thickened portion from the outer end thereof to a point at least half the distance to the opposite inner end of said thickened portion to form a socket having an internal diameter at the end of the tube at least as great as the external diameter of the main body of the tube, confining the expanded portion within a space with a substantial clearance around the outside of said portion whereby a substantial length of the socket wall is unsupported around the outside, and buckling the intermediate part of the expanded portion radially outwardly against the wall of said clearance by subjecting the outer end of the expanded portion to axial compression while securing said end against radial movement.

3. A method of forming a flange on a metal tube, which comprises gathering metal from one end of the tube to form a thickened portion gradually increasing in thickness from the inner end thereof to a point intermediate its ends, expanding the thickened portion from the outer end thereof to a point at least half the distance to the opposite inner end of said thickened portion to form a socket of a length substantially greater than the thickness of the socket wall, confining the expanded portion within a space with a substantial clearance around the outside of said portion whereby a substantial length of the socket wall is unsupported around the outside, and buckling the intermediate part of the expanded portion radially outwardly against the wall of said clearance by subjecting the outer end of the expanded portion to axial compression while securing said end against radial movement.

4. A method of forming a flange on a metal tube, which comprises gathering metal from one end of the tube to form a thickened portion gradually increasing in thickness from the inner end thereof to a point intermediate its ends, expanding the thickened portion from the outer end thereof to a point at least half the distance to the opposite inner end of said thickened portion, confining the expanded portion within a space with a substantial clearance around the outside of said portion whereby a substantial length of the socket wall is unsupported around the outside, and buckling the intermediate part of the expanded portion radially outwardly against the wall of said clearance by subjecting the outer end of the expanded portion to axial compression while securing said end against radial movement.

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