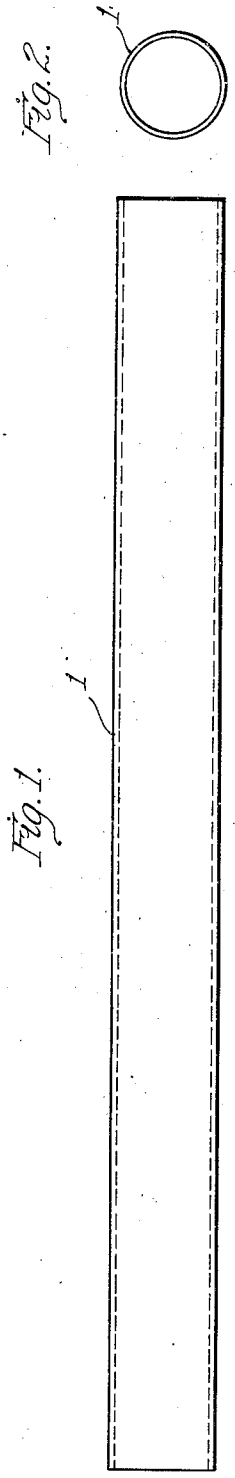
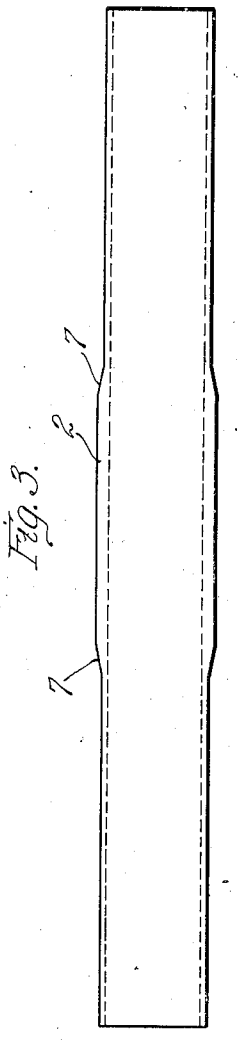
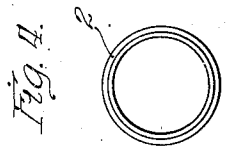
April 25, 1933. E. B. CLARK 1,905,150

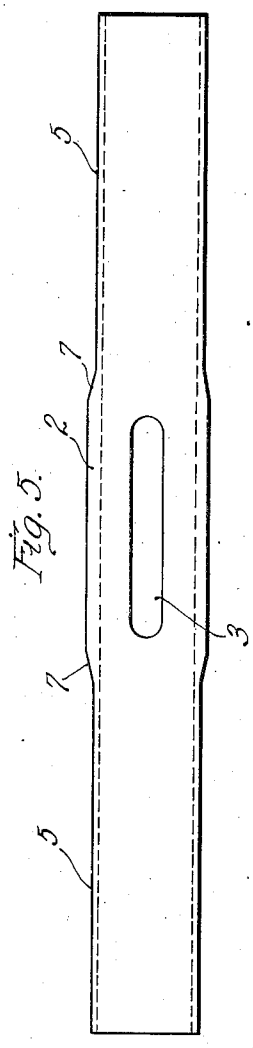
METHOD OF MAKING AXLE HOUSINGS

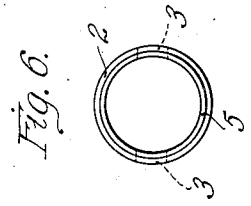
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METHOD OF MAKING AXLE HOUSINGS

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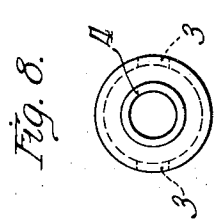


Fig. 8.

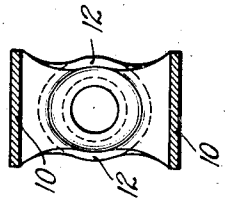


Fig. 10.

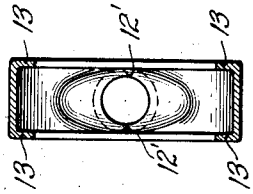


Fig. 12.

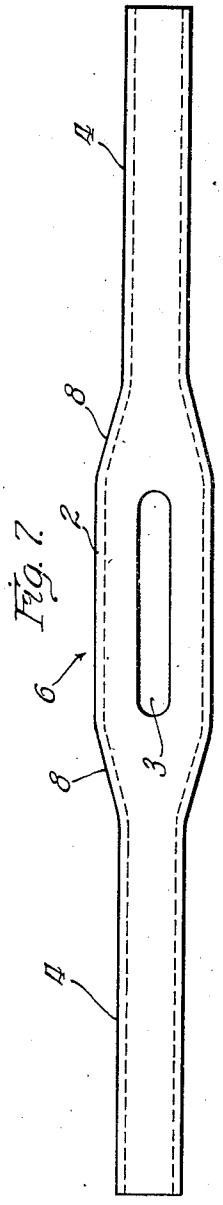


Fig. 7.

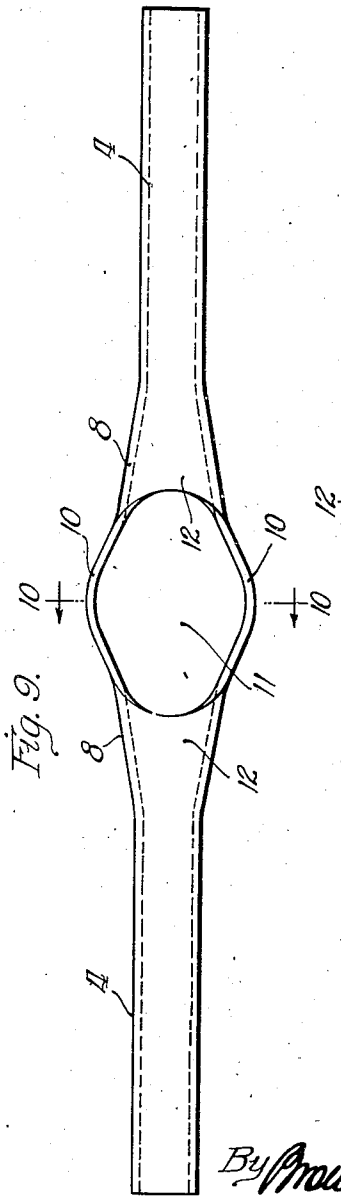


Fig. 9.

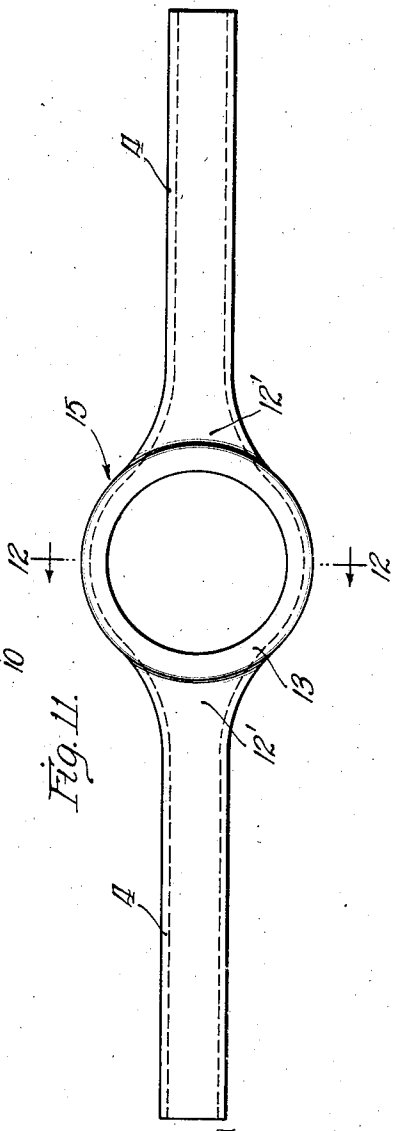


Fig. 11.

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Fig. 14.

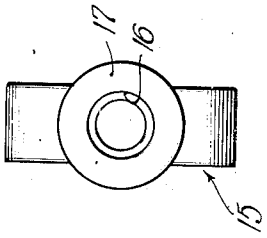


Fig. 17.

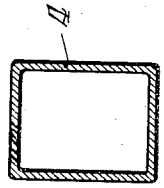


Fig. 13.

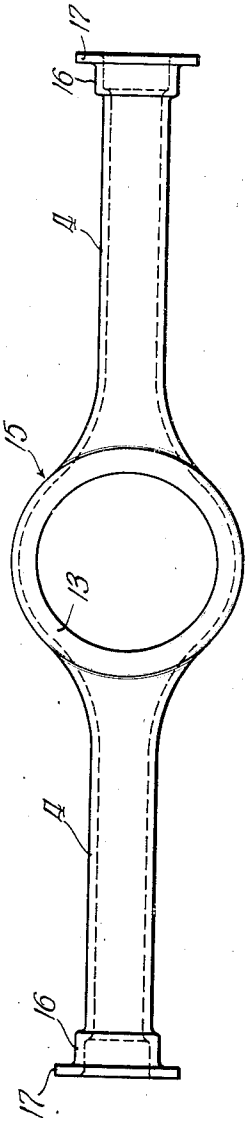


Fig. 16.

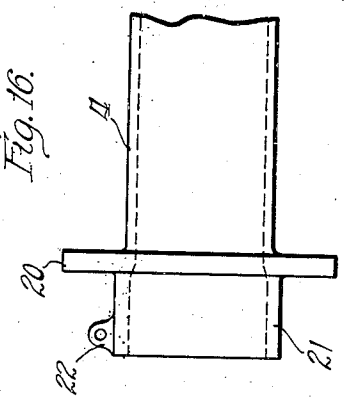
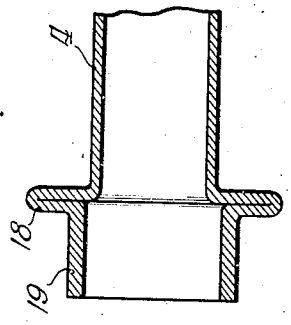


Fig. 15.



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1,905,150

UNITED STATES PATENT OFFICE

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METHOD OF MAKING AXLE HOUSINGS

Application filed April 9, 1928. Serial No. 268,503.

My invention relates to the manufacture of rear axle casings and the like and discloses and claims a particular method of manufacture and resulting structure of the general method and structure disclosed and claimed in the copending application of George Spatta, Serial No. 416,537, filed December 26, 1929.

I am aware that it has heretofore been proposed to form rear axle casings from wrought tubing by slitting the central part of the tube and spreading the same to form an open banjo frame. Heretofore the formation of a rear axle casing from a piece of seamless tubing or the like has resulted in a structure of undesirable characteristics, one feature of which has been the difference in thickness between the banjo frame portion and the arms on each side of it. If a piece of tubing heavy enough to make the banjo frame is employed as the blank, then shrinking of the tubing at the ends to bring it down to the proper size for the arms of the axle increases the wall thickness to an undesirable extent. For example, if a piece of tubing having a wall thickness of $\frac{1}{16}$ of an inch is employed the ends or arms of the axle will be thickened to approximately $\frac{3}{8}$ of an inch, which is thicker and heavier than necessary. Such unnecessary weight on the rear axle involves needless initial expense and is highly undesirable from an operating standpoint and should be avoided.

According to the present invention I am able to form a rear axle casing in which the relative thickness of the arms and of the banjo frame is under control so that the desired form and strength without surplus weight can be produced. This control I secure by treatment of the tube prior to slitting and forming.

While theoretically it might be possible to thicken the walls of the tube or banjo frame after slitting or slotting the tube, in practice this is not feasible because as soon as the tube is cut longitudinally its hoop strength is gone and control of the metal is lost.

I start with a tube of suitable diameter and length but of relatively thin wall. The diameter of the tube is preferably smaller than the diameter of the banjo frame and larger than the desired diameter of the arms. The thickness of the wall of the tube which I employ is such that shrinkage of the diameter of the arms results in the desired wall thickness of the arms. The desired thickness of wall at the central part where the banjo frame is formed is secured by initial upsetting before slitting. After the proper stretching and forming of the central part of the tube to provide the banjo frame, the wall of the banjo frame will be of the desired thickness, namely substantially that of the finished arms. Obviously within limits any desired relation of wall thickness and/or diameter may thus be secured. Preferably I employ seamless tubing so that no weak spots or flaws will be contained in the resulting structure, but obviously butt or lap-welded tubing could be employed.

In the forming of the banjo frame the walls on each side of the slotted portion are spread out sidewise substantially straight so that they form virtually tubular walls at right angles to the axis of the original blank. Then by inserting stretching dies on the inside and a contracting die on the outside these walls are formed into a transverse cylindrical banjo frame with inturned flanges parallel to each other and to the longitudinal axis of the blank.

The ends of the arms are preferably upset and expanded, or may otherwise be formed in a variety of ways to provide a bearing seat or housing and a brake plate.

Now in order to acquaint those skilled in the art with the manner of practicing my invention I shall describe in connection with the accompanying drawings typical steps resulting in the novel form of axle casing embodying my invention.

In the drawings

Fig. 1 is a side elevation and Fig. 2 an end view of the blank, which is a piece of seamless tubing.

Fig. 3 is a side elevational view and Fig. 4 an end view of the blank after the operation of upsetting the central part of the tube and thickening the walls of the same.

Fig. 5 is a side elevational view and Fig. 6 an end view of the blank after the operation of slotting the central part.

Fig. 7 is a side elevational view and Fig. 8 an end view of the blank after the operation of reducing or shrinking the arms on each side of the center.

Fig. 9 is a side elevational view and Fig. 10 a transverse cross section of the blank after the operation of opening up the slotted central portion.

Fig. 11 is a side elevational view and Fig. 12 a transverse cross section through the banjo frame, showing the axle housing with the completed central banjo frame.

Fig. 13 is a side elevational view and Fig. 14 an end view of the completed axle casing after the upsetting and expanding of the ends of the arms to provide the bearing seats and flanges for mounting the brake plates.

Fig. 15 is a fragmentary longitudinal section through a modified form of axle casing in which the end of the arm is expanded out and then collapsed to provide a flange for the brake plate and a seat for the bearings.

Fig. 16 is a side view of a modified form of end of the axle casing; and

Fig. 17 is a cross section of the casing shown in Fig. 16.

Referring now to Figs. 1 and 2, I employ in a typical practice of my process a seamless steel tube 1 about 55 inches long, 4¾ inches in diameter and having a wall section ⅛ of an inch thick. While I refer to the above dimensions as explaining the manufacture of a specific form of axle casing, I do not intend by these dimensions to limit the invention but merely to explain a specific way in which the invention may be carried out.

This length of tubing is heated and is then provided with an internal mandrel and subjected to upsetting pressures so that the walls along the central part which are softened by heat are thickened as indicated in Figs. 3 and 4.

A die is employed to control the extent to which the walls are increased in thickness throughout this portion which is required to form the banjo.

While I have described the walls as increased in thickness by spreading outwardly, it is to be understood that I may, if desired, restrain the metal from flowing outwardly and cause it to flow inwardly instead, but in the preferred practice of my invention I maintain the inner diameter substantially uniform and thicken the walls outwardly along the central portion, as indicated at 2 in Figs. 3 and 4, for the purpose of providing the desired thickness in forming the banjo.

Thereafter, as shown in Figs. 5 and 6, the central part is slotted longitudinally as indicated at 3—3 in Figs. 5 and 6, this operation of slotting being performed by the use of a suitable horn die and punch. While I have shown the central part of the blank as slotted by a relatively large slot or opening, it is to be understood that by the term "slotting" I intend to include also cutting the walls longitudinally which is often termed "slitting". I prefer to cut the slot to permit the entrance into the opening of a suitable spreading die, and since sufficient material is present because of the initial thickening or upsetting operation as indicated in Figs. 3 and 4, the work of spreading the banjo portion is facilitated, and the use of the relatively large slot is permissible because of the presence of sufficient metal at this central part.

After the slotting operation the blank is then treated to bring it to the form shown in Figs. 7 and 8 by shrinking the arms or ends 4—4 by passing a shrinking die endwise over the end portions 5—5 of Fig. 5 to bring the blank to the form shown in Fig. 7 wherein the thickness of the ends or arms 4—4 is substantially the same as the thickness of the walls 2 of the banjo portion 6.

The arms 4—4 are now shrunk to approximately 3 inches in diameter, and they have a wall thickness of approximately $\frac{3}{16}$ of an inch, thereby providing a substantially uniform thickness throughout the entire length of the blank.

It is to be observed that the central portion 2 which later becomes the banjo has tapering shoulders 7—7 (see Figs. 3 and 5), and when the shrinking of the arms or ends 4—4 occurs the tapered tubular portions 8—8 are formed in a manner which merges the tapered wall thickness 7 into the tapering tubular walls 8 in such a manner as to bring the thickness throughout the blank to substantially a common value.

The blank shown in Fig. 7 is then subjected to a spreading action of the slot 3 to bring the blank to the form shown in Figs. 9 and 10 by flattening or straightening out the walls 10—10. That is to say, the central part of the blank now has the walls 10—10 disposed transverse to the longitudinal axis of the blank in such a way as to define a transverse cylindrical opening 11, that is to say, consider the walls 10—10 as symmetrical walls defining a part of the opening 11, the cylindrical walls 10—10 merging into the conical tubular walls 8—8 and being joined by webs or gussets 12—12 on each side, which gussets are really a part of the tapered tubular walls 8—8. The attempt at this stage is to convert the cylindrical walls about the opening 3—3 as nearly as possible into a transverse cylinder intersecting and at right angles to the axis of the main body of the blank.

The blank shown in Figs. 9 and 10 is next treated to bring it to the form shown in Figs. 11 and 12 by the insertion of an internal ex-

panding punch over which there is brought an external contracting die. The forming of the opening 11 from the slots 3 can be performed by the use of an internal expanding, stretching die, which spreads the walls surrounding the slots 3 into sheet-like portions 10 defining the opening 11. In the transformation of the blank from the shape shown in Figs. 9 and 10 to the form shown in Figs. 11 and 12 the internal expanding die stretches the walls about the opening 11 in Fig. 9, and it will be seen that there would be a tendency to stretch and decrease the wall thickness of the gussets 12—12 on each side, but this tendency is counteracted by the folding inwardly of the edges of flanges 13—13. While the gusset portions 12—12 are increased in their vertical dimension they are actually brought nearer together, and hence a surplus of metal from that operation permits the opening up or spreading to the shape shown at 12′—12′ in Figs. 11 and 12. The flanges 13—13 are formed parallel and are spaced apart a distance which is approximately that of the outer diameter of the arms 4—4, although this is optional. That is to say, the depth of the banjo 15 which is formed at this stage may be varied within limits and the width of the annular flanges 13 may likewise be varied within my invention.

It will be observed that the banjo portion 15 has a channel section which provides great strength for the material employed, and since the maximum stress is at the central portion the increase in vertical depth and the highly advantageous channel section at the central portion provides ample strength in the resulting axle casing.

After the casing has been brought to the form shown in Figs. 11 and 12 it is desirable that suitable provision be made for mounting the axle bearings and brake plate, and there are several ways in which I do this. The preferred form is shown in Figs. 13 and 14. In this form I heat the ends of the arms 4—4 and upset and expand the same in one operation with a suitable punch and die, thereby forming on the end of the arm 4 an enlargement 16 terminating in a flange 17. This enlarged or expanded end 16 serves to receive the bearing or outer bearing race for the axle of the rear wheel, and the flange 17 is adapted to receive and support the brake plate which is riveted thereto.

While in the form shown in Figs. 13 and 14 the ends are upset with the flange on the extreme outer end, it is possible to upset the end of the arm in a number of different ways to conform to the desired requirements of the rear axle and its bearings. For example, in Fig. 15 the arm 4 is first expanded or bulged out and then the bulge is flattened or folded back endwise to form the flange 18 integral with the arm 4 and with the thickened end portion or housing 19 of an internal diameter somewhat larger than the internal diameter of the arm 4 and with the walls thereof slightly thickened by upsetting.

The inside of the portion 19 may be of any desired diameter to receive a suitable bearing race or bearing.

As shown in Fig. 16 the end of the arm 4 is upset and an integral solid flange is formed as indicated at 20 to receive the brake plate, and outside of the flange 20 another upset portion 21 is provided for receiving the bearing race or bearing, and this portion 21 may have formed integral therewith ears 22 which are finished by a slot cut between them and through the adjacent walls of the portion 21. The portion 21 and the ears 22 thereby serve as a split clamp to lock the bearing.

Whereas in the prior description I have referred to the arms 4 as being cylindrical, that is, round cylinders, the casing may be reduced to a rectangular tubular shape particularly along the ends of the arms 4 for the purpose of attaching spring pads.

The manner of use of the axle casing will be obvious to those skilled in the art. Suitable cover plates are secured to the flanges 13 of the banjo frame 15 to house differential or other mechanism for connecting a propeller shaft to the axle sections which are housed within the arms 4—4, the bearings for which are provided at the outer ends of the arms 4—4, for example in the enlargements 16—16 of Fig. 13. The axle casing may be employed in the construction of a rear axle such as is disclosed in the copending application of Edmund C. Mogford, Serial No. 28,598, filed May 7th, 1925, issued January 28, 1930, as Patent No. 1,744,790.

It is to be observed that I start with a tube having walls thinner throughout than any of the walls of the finished casing. A part of the increase of thickness of the walls is secured by a preliminary upsetting and another part by shrinking of the diameter.

While I have described the employment of a specific size and form of tubing, it is to be understood that my invention is not to be limited to the specific size and form as the invention is applicable to any size of tubing and to any reasonable increase in wall thickness, whether the said increase in wall thickness extends outwardly or inwardly or partly in both directions. I, therefore, do not intend to be limited to the precise details shown, nor to the sequence of steps which I have above recited, as it will be apparent to those skilled in the art that these may be varied without departing from my invention.

I claim:

1. The method of making an axle housing from a piece of seamless tubing which consists in upsetting the central part of a length of tubing to increase the wall thickness thereof, slotting the central part of the blank for a suitable distance parallel with

its axis and at diametrically opposite points substantially midway of its length, shrinking the ends of the blank to reduce the diameter thereof and to thicken the walls thereof, spreading the slotted portion into transverse tubular walls, expanding the central portion of said tube and folding over the edges thereof to form annular flanges substantially parallel to each other and to the longitudinal axis of the housing.

2. The process of making an axle housing from a thin walled tube which consists in upsetting the central part of the tube to thicken the wall of the same where the banjo frame is to be constructed, slotting the thickened portion, spreading the slotted portion and shrinking the diameter of the tube on each side of the slotted portion.

3. A blank for axle casings comprising a thin walled tube of a length approximately the length of a finished axle casing and having an integral upset portion, said portion having thickened walls providing sufficient stock to form a banjo frame and having diametrically disposed slots therethrough.

4. The method of making an axle casing which comprises upsetting and thickening the wall of a thin walled tubular blank along its central portion, cutting diametrically disposed slots in said thickened portion and shrinking the diameter of the end portions, simultaneously thickening the walls thereof.

5. In the method of making an axle casing from a thin tubular blank the process of thickening the wall of the tubular blank throughout, which comprises upsetting one portion of the wall of the blank and shrinking the diameter of another portion of the wall of said blank.

6. In the method of making an axle casing from a thin tubular blank, the process of thickening the wall thereof which comprises thickening a part of the wall of the blank by endwise contraction and thickening another portion of the wall of the blank by a circumferential contraction.

7. The method of forming the outer end of a tubular axle casing which comprises upsetting and expanding the extreme outer end, forming an integral circumferential flange and forming a lug integral with the outer expanded end.

8. The method of making an axle casing from a thin-walled tubular blank which comprises upsetting the central longitudinal portion of the blank to increase the wall thickness thereof, slotting opposite sides of said portion, shrinking the end portions diametrically and simultaneously increasing the wall thickness thereof, spreading the edges of the slotted portion, stretching out the central part of the slotted portion into transverse cylindrical form, and folding over the edges into parallel annular flanges.

9. The method of making an axle casing from a thin-walled tubular blank which comprises upsetting the central longitudinal portion of the blank to increase the wall thickness thereof, slotting opposite sides of said portion, shrinking the end portions diametrically and simultaneously increasing the wall thickness thereof, spreading the edges of the slotted portion, stretching out the central part of the slotted portion into transverse cylindrical form, folding over the edges into parallel annular flanges, upsetting the ends of the blank and forming flanges from said upset portion.

10. The method of making an axle housing from a piece of tubing which comprises shrinking the central part of the tubing axially to increase the wall thickness and maintaining the diameter approximately unaffected, shrinking the ends at each side of the central part radially to increase the wall thickness thereof and expanding the diameter of the central part to provide an enlarged housing.

11. The method of preparing a thin walled tubular blank for the construction of an axle casing which consists in endwise shrinkage of the blank along its central portion to increase the wall thickness of the same and forming diametrically disposed slots through said thickened walls of the central portion.

In witness whereof I hereunto subscribe my name this 20th day of March, 1928.

EUGENE B. CLARK.