S. E. DIESCHER.

MANUFACTURE OF SEAMLESS TUBES.

APPLICATION FILED MAY 22, 1914.

1,139,957.

Patented May 18, 1915.

2 SHEETS—SHEET 1.

FIG. 1.

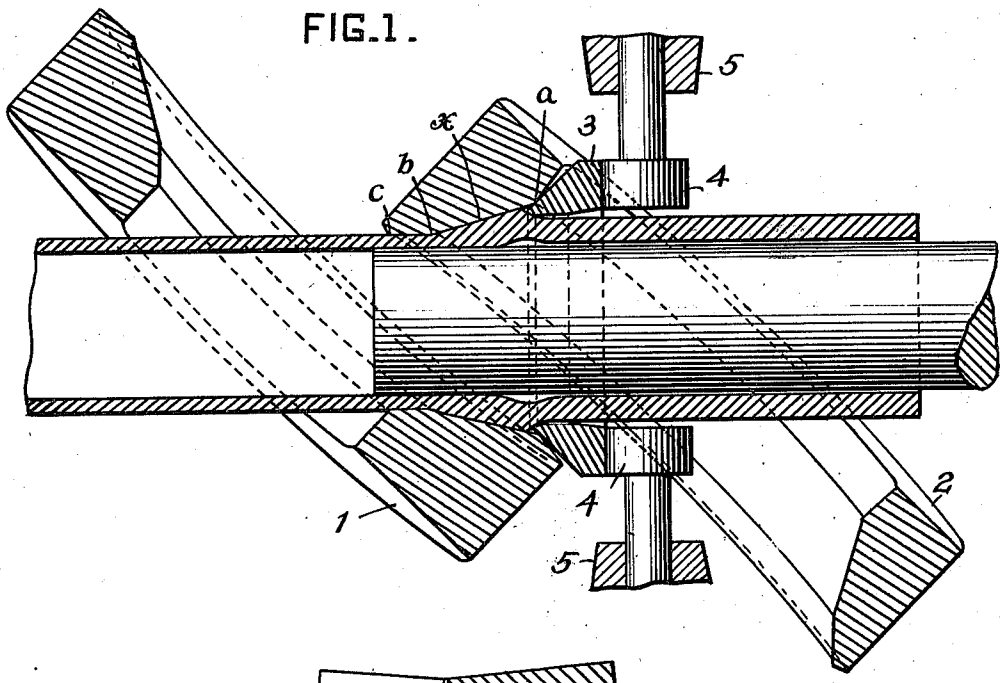
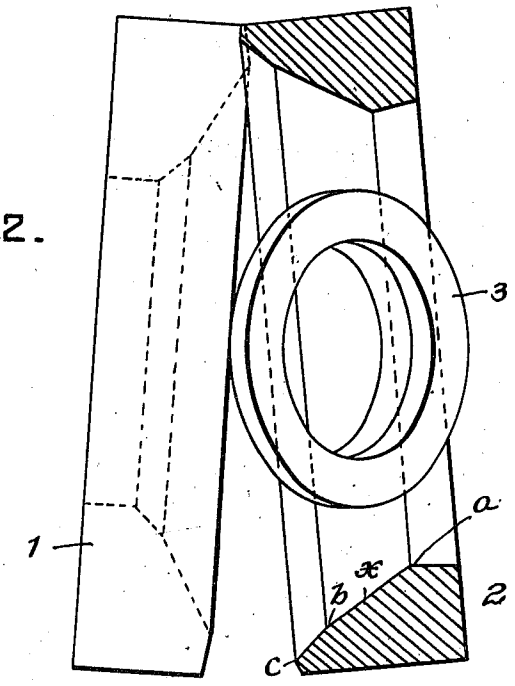


FIG. 2.



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2 SHEETS—SHEET 2.

FIG. 3.

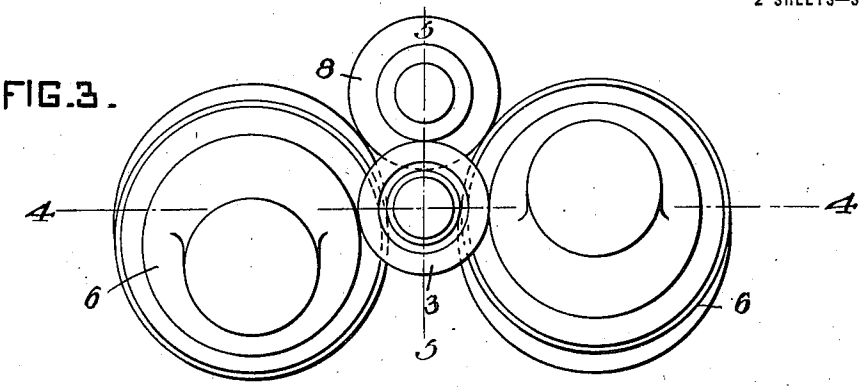


FIG. 4.

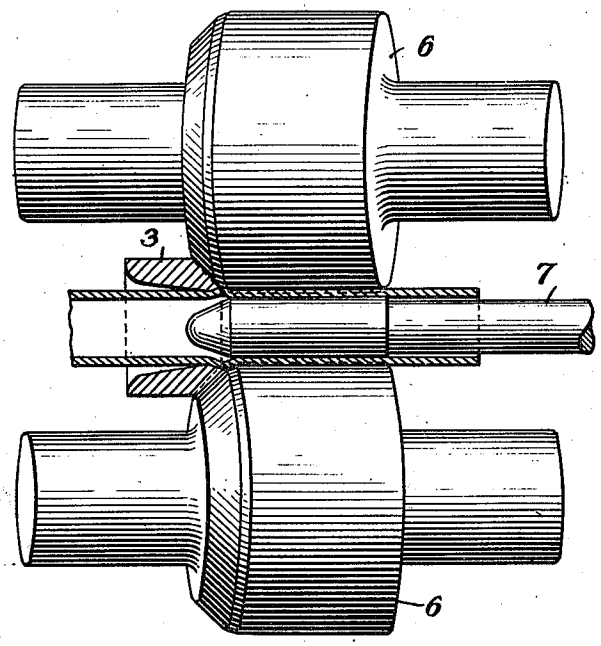
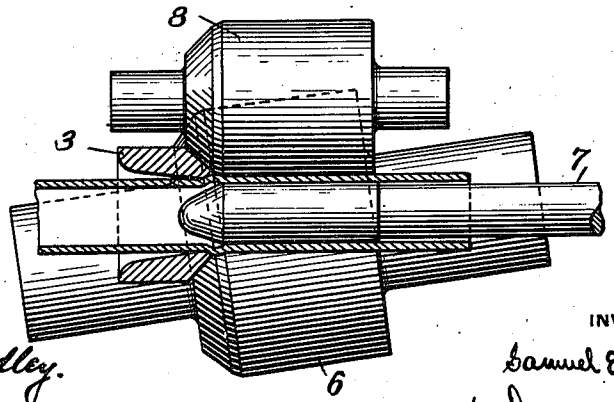


FIG. 5.



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MANUFACTURE OF SEAMLESS TUBES.

1,139,957. Specification of Letters Patent. Patented May 18, 1915.

Application filed May 22, 1914. Serial No. 840,190.

To all whom it may concern:

Be it known that I, SAMUEL E. DIESCHER, residing at Pittsburgh, in the county of Allegheny and State of Pennsylvania, a citizen of the United States, have invented or discovered certain new and useful Improvements in the Manufacture of Seamless Tubes, of which improvements the following is a specification.

In all rolling operations the metal will flow in the direction of movement of the piece, causing elongation and if not confined will also flow at an angle to the line of feed, and the movement of the metal in these directions will be approximately proportional to the relative dimensions of the area of contact of the rolls on the metal. As for example in rolling sheets, the areas of contact of the rolls with the metal in the direction of movement of the sheet is very narrow, while in the direction transverse of the sheet, the contact area is very wide and is equal to the width of the sheet. Hence the flow of metal transverse of the feed of the sheet is practically *nil*, and the entire flow is in the direction of the movement of the article.

In the Mannesmann and other type of mills employing reducing surfaces acting at an angle to the axis of the article, for manufacturing seamless tubes and also in reeling machines, the rolls are arranged so that the tube is fed through between the rolls by a screw-like motion. In such mills, whether the reducing surfaces are convex or approximately flat, the dimension of the area of contact of such surfaces on the metal is in the direction of feed of the tube or bar very much greater than its extent at an angle to the direction of feed, and hence elongation is due more to a spiral movement of the metal than to its direct flow in lines parallel with the axis of tube. As will be readily understood the spiral flow of the metal subjects the latter to very severe strains which are increased by the flow parallel with the axis. As only the surface metal is displaced in the reeling operation, these strains are negligible, but in reducing hollow billets to tubes as in the types of mill referred to the entire mass of metal is displaced as described, and subjected to such severe strains that only a high grade of metal can be successfully employed.

By the employment of concave reducing surfaces properly proportioned as regards circumferential and longitudinal dimensions, the relative dimensions of the areas of contact existing in convex surfaces, can be reversed, that is the contact in direction of feed of the tube will be shorter than the extent of contact circumferentially. Hence in using concave reducing surfaces the greater proportion of the metal displaced will move substantially parallel with the axis of the tube, and the metal will be subjected to less punishment.

It is believed that in all rolling operations there occurs a backward displacement of metal which under some conditions will cause a swell or enlargement in front of the rolls tending to increase the area of contact of the roll surfaces with the metal. Although the frictional engagement of the reducing surfaces with the surfaces of the swell or enlargement would be relatively small, there would be in such cases a tendency to force in more metal between the rolls. When reducing tubes by surfaces as hereinbefore described, the reducing surfaces will have such an effect on the metal of the swell or enlargement as to cause it to move to points where the metal is unconfined and impart an oval or irregular cross-sectional shape to the portion of the billet being operated on, and the irregularity thus imparted will appear although to a less degree in the finished tube. By reason of this action it has been found practically impossible to control the feed of the tube and the feed will generally increase as reduction proceeds.

The invention described herein has for its object the reduction of the percentage of metal flowing circumferentially relative to that flowing longitudinally in treating hollow billets and tubes, thereby avoiding the straining of the metal; the regulation of the feed of the billets and tubes between the rolls; the application of a drawing or pulling force during the reduction thereby improving its quality; reducing the tendency of such movement of the metal as will impart an oval shape to the metal being worked on, and to insure uniform external and internal surfaces in the finished article.

The invention is hereinafter more fully described and claimed.

In the accompanying drawings forming a part of this specification, Figure 1 is a sectional view showing concave reducing surfaces for rolling down hollow billets and having my improvement applied thereto;

Fig. 2 is an end elevation of the reducing members, one being shown in section and showing the position of the controlling ring relative to such members; Fig. 3 is an end elevation of the rolls of a reeling machine, and showing the controlling ring in position; Figs. 4 and 5 are sectional views on planes indicated respectively by the lines IV—IV and V—V Fig. 3.

While the improvement forming the subject-matter of this case is shown and described as regards the reduction of hollow billets in connection with the form of reducing surfaces shown and described in Letters Patent No. 1,067,806 dated July 22d, 1913, the improvement is equally applicable to the rolling down of hollow billets by convex surfaces acting at an angle to the axes of the article under reduction, and is also adapted for use in connection with reeling machines.

By reference to Fig. 1, it will be seen that the reducing surfaces of the annuli 1 and 2 are divided into what may well be termed preliminary surfaces extending from *a* to *b*, and final or finishing surfaces extending from *b* to *c*. As described and shown in said patent the annuli are so constructed and adjusted relative to each other and to the axis of the tube while passing through, that the surfaces between *b* and *c* which receive the metal from the surfaces between *a* and *b* and effect the final reduction are substantially parallel with or at a very acute angle to the axis of the tube. The initial or preliminary surfaces *a b* have an inclination to the axis of the tube much less acute than that of the surfaces *b c*. These surfaces are made of such a length that the mouth of the bell which they form for the reception of the billet has a diameter greater than that of the billet to be reduced. When the billet is fed into the bell, its end will strike the surfaces *a b* at the points *x* approximately midway of the length of these surfaces. It will be understood however that the points of contact of the billets on these surfaces will depend for a given size of annuli, on the external diameter of the billet the larger the billet the farther forward will be the points of contact and vice versa.

As the billet is drawn in by the screw-like action of the annuli, there will be a gradual reduction of the billet until it passes between the surfaces *b c*, when the rate of reduction becomes small. By the action of the surfaces between *a b* and *b c*, a portion of the metal will flow longitudinally and a portion circumferentially dependent as before stated on the relative dimensions (circumferential and longitudinal) of the areas of contact of these surfaces with the metal. By reference to Fig. 1 it will be seen that there is also a displacement of the metal forwardly from the points of contact *x*. This forward displacement increases the area of contact between the annuli and the metal both circumferentially and longitudinally. The feed of the billet tends to crowd this forwardly displaced metal between and through the contracting walls of the bell formed by the annuli, but as movement of more metal longitudinally is practically impossible, there will be an increased flow circumferentially due in part to frictional engagement with the revolving annuli and partly because there will be less resistance to flow in that direction. In this circumferential movement the metal will pass beyond the confining surfaces of the annuli and will therefore move outwardly from contact with the mandrel producing an oval shape. This added circumferential flow due as stated to the crowding into the bell of the forwardly displaced metal, also produces irregularities of feed.

As the irregularity of feed and the imparting of an oval shape are due to the crowding of more metal into the bell formed by the annuli than the reducing surfaces can properly treat, provision is made for so retarding the onward movement of the billet that metal will be presented to the reducing surfaces only as they are designed to properly treat it in the normal operation of the annuli. This retardation should be capable of automatic adaptation to variations of reductions, and should not prevent the movement of such quantity of metal as the reducing surfaces can properly care for. A convenient means for retarding the movement of the billet and consequent crowding of too much metal, into the bell formed by the annuli consists of a floating ring 3 of any suitable length and having such an internal diameter relative to the external diameter of the billet as to permit of the insertion of the billet therethrough and insure that the ring will so engage the billet as to retard the flow of metal as hereinafter stated. The ring is externally tapered so that its rear end will project as far into the bell as the size of the billet will permit. The bore of the ring should be slightly tapered so that the billet can be readily inserted into and slide without material friction through the ring except as hereinafter stated.

The billet after passing through the ring encounters the reducing surfaces of the annuli, and by these surfaces the metal is caused to flow longitudinally and circumferentially as before stated. There is also a forward displacement of metal which will extend forward into the floating ring, thereby causing such a frictional engagement between the ring and billet as to retard the onward movement of the billet, the ring

being held from movement in the direction of feed by its bearing against the annuli. The frictional engagement between the ring and billet will be, roughly stated, proportional to the metal crowded forward into the ring, and during the early stages of reduction the retarding action of the ring increases progressively until the onward movement of the unreduced portions of the billet is checked. But as the reducing surfaces of the annuli are constantly pushing the metal along, they must when the billet is checked draw their supply from the metal within the bell formed by the annuli and crowded forward as before stated, thereby reducing the congestion in the bell and in the rear end of the floating ring. As soon as the pressure of the metal within the ring is reduced the billet is free to move forward through the ring until the metal between the surfaces *a b* and in the rear end of the ring becomes congested thereby increasing the grip of the ring on the billet and checking its onward movement. It has been found that in a very short time a balance is established and the billet will move uninterruptedly forward.

When the onward movement of the billet is checked the continued flow of the metal will reduce the effectiveness of the surfaces *a b*. That is to say the frictional engagement of the surfaces will decrease progressively from the line *b* forwardly and hence the tendency of the surfaces *a b* to move the metal circumferentially becomes less effective and there will be a proportional increase of flow longitudinally.

When the onward movement of the billet is checked while the onward flow of metal continues, the metal lying between the ring and the surfaces which cause the onward flow will be subjected to a stretching action, so that in the practice of the improvement described herein the metal is simultaneously reduced by pressure and tension, thereby greatly improving the quality of the finished tube.

As the ring rotates with the annuli, there will not be any material resistance to the rotation of the billet by the annuli. In order to avoid the forward shifting of the ring by the metal when crowded forward by the reducing action of the annuli, the ring may be held in operative relation to the annuli by rollers 4 carried by shafts longitudinally movable in bearings 5 in the housing of the mill. By properly adapting the bore of the ring to the external diameter of the billet a rate of feed of the billet can be maintained at the center of the reducing area as it will be at the beginning of the reducing action before the forward displacement occurs. This will naturally cause a slippage of the reducing faces which tend to feed faster than the billet travel throughout the entire length of the portion of the billet operated on; and this slippage has in turn a pronounced tendency to move the material longitudinally.

It is characteristic of the reduction by surfaces moving in a direction forming an acute angle with the axis of the article operated on, that as the metal is gripped and confined only at two diametrically opposite points, the metal in its circumferential flow will at points intermediate the reducing surfaces move away from the mandrel and the resulting tube will be irregular in cross-section. But as in the improved method herein described, the metal tending to move transversely away from the mandrel is subjected to a longitudinal pull as before described, such movement away from the mandrel is reduced and by properly adapting the bore of the ring so as to obtain a maximum stretching action, the inner wall of the tube may be held close to the mandrel. As hereinafter stated the reducing surfaces *a b* are so constructed that there will be a greater flow of the metal acted upon by said surfaces, longitudinally than circumferentially, and as the stretching action occurs intermediate the surfaces *b*. *c*., and the ring, the resulting tube will be practically round.

The floating ring can be used in connection with convex reducing surfaces whether used for reducing a hollow billet to a tube or adjusted merely for straightening and truing tubes as shown in the reeling machine illustrated in Figs. 3, 4 and 5.

The reeling machine shown in Figs. 3, 4 and 5 consists of rolls 6 having their axes at an angle to the direction of feed of the tube so that the latter is moved forward by a screw-like action of the rolls on the tube. A mandrel 7 is so arranged between the rolls that the tube as it is drawn between the rolls will be forced over the mandrel. In feeding, the tube passes through the ring 3 before entering the bite of the rolls, and although the metal displaced in reeling is small compared to the displacement effected in reducing hollow billets, the action of the ring does not differ in kind from that explained in connection with the reduction of billets.

It is believed that by properly adapting the bore of the ring to the diameter of the tube, the combined stretching and drawing action to which the tube is subjected in the practice of the method described herein, will in most cases render sizing and subsequent operations unnecessary.

In the form of reeling machine herein shown the main rolls 6 are so arranged that the axis of the tube when passing between the rolls is slightly above the narrowest space between the rolls, and in order to avoid an upward movement of the tube and mandrel due to such an arrangement of the

rolls 6, a third roll 8 is employed. It will be understood that the improved method is not dependent for its practice on any particular form or construction of reeling machine.

I claim herein as my invention:

1. As an improvement in the art of manufacturing tubes, the method herein described, which consists in subjecting the hollow articles to the action of reducing surfaces rotating on axes at an angle less than a right angle to the axis of such articles and subjecting the metal while acted on by the reducing surfaces to longitudinal tension governed by the circumferential flow of the metal.

2. As an improvement in the art of manufacturing tubes, the method herein described which consists in applying reducing pressure to a hollow article at an angle less than a right angle to the axis of the article and progressively around the article and longitudinally stretching the metal while being reduced, and governing the stretching by the circumferential flow of the metal.

3. As an improvement in the art of manufacturing tubes, the method herein described which consists in subjecting a hollow article to concave reducing surfaces rotating in planes at acute angles to the axis of the articles, longitudinally stretching the metal while being acted on by such surfaces and governing the stretching action by the circumferential flow of the metal.

4. As an improvement in the art of manufacturing tubes, the method herein described which consists in applying reducing pressure to a hollow article at an angle less than a right angle to the axis of the article and progressively around the article, and diverting the circumferential flow of metal induced by the reducing surfaces by retarding the onward movement of the billet.

5. As an improvement in the art of manufacturing tubes, the method herein described which consists in applying reducing pressure to a hollow article at an angle less than a right angle to the axis of the article and progressively around the article, applying a retarding pressure to the billet and automatically varying such pressure.

6. In a machine for reducing hollow billets, the combination of two rotating members arranged to operate on the billet in direction at an angle less than a right angle to the axes of the billet, and a ring arranged in front of the rotating members and having an internal diameter slightly greater than the external diameter of the billet.

7. In a machine for reducing hollow billets, the combination of two rotating members arranged to operate on the billet in direction at an angle less than a right angle to the axis of the billet, and a ring arranged in front of the rotating members and having such an internal diameter relative to the external diameter of the billet, that while permitting the insertion of the billet it will, during the reducing operation, affect a retardation in the onward flow of the metal.

8. In a machine for reducing hollow billets, the combination of two rotating members arranged to operate on the billet in directions at an angle less than a right angle to the axes of the billet, a ring arranged in front of and adapted to be rotated by the said members and having an internal diameter slightly greater than the external diameter of the billet.

9. In a machine for reducing hollow billets, the combination of two rotating members having concave reducing surfaces and arranged to operate on the billet in directions at an angle less than a right angle to the axis of the billet, and a ring arranged in front of the rotating members and having an internal diameter slightly greater than the external diameter of the billet.

10. In a machine for reducing hollow billets the combination of two rotating members having concave reducing surfaces and arranged to operate on the billet in directions at an angle less than a right angle to the axis of the billet, a ring arranged in front of and adapted to be rotated by the said members and having an internal diameter slightly greater than the external diameter of the billet.

In testimony whereof, I have hereunto set my hand.

SAMUEL E. DIESCHER.

Witnesses:

ALICE A. TRILL,

THOS. B. JOYCE.