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METHOD AND APPARATUS FOR SIZING TUBES

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Fig 1

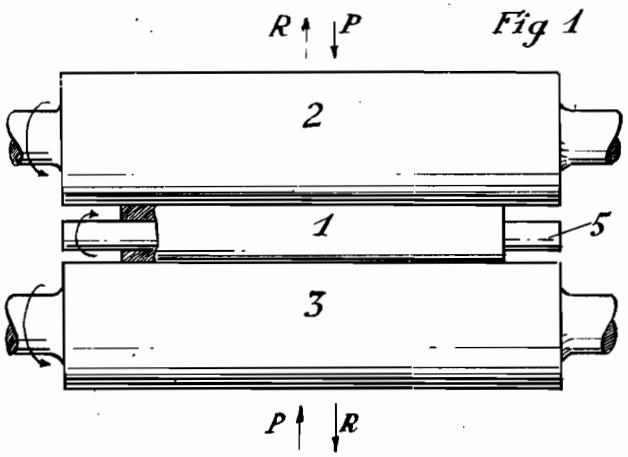


Fig. 2

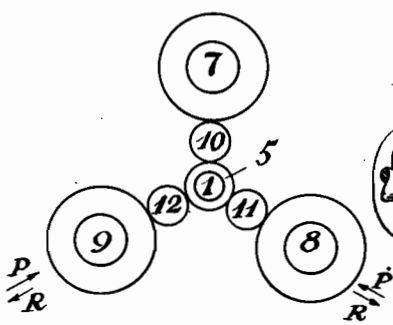
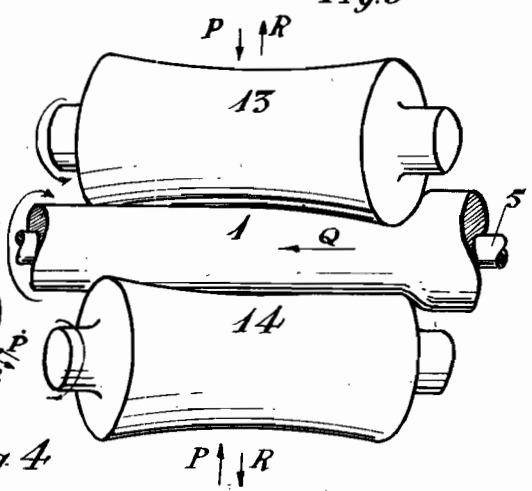


Fig. 3



Q P Fig. 4

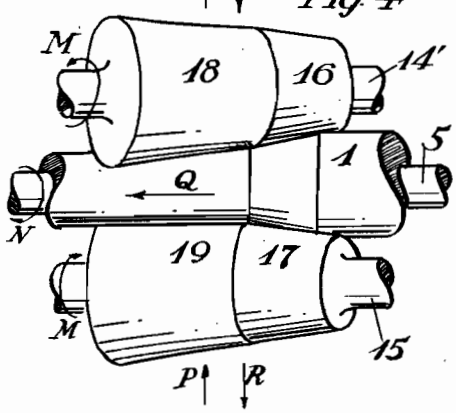
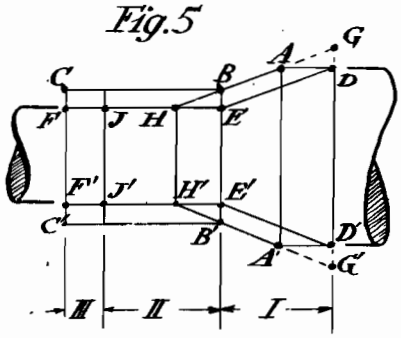


Fig. 5



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ALIEN PROPERTY CUSTODIAN

ROTARY FORGING PROCESS FOR HOLLOW METALLIC MATERIAL

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Among the prior forging processes of hollow metallic materials hitherto, the processes, which have imparted to it the best operative effect in view point of quality is the forging one by means of press.

In this case, however, the external forces act only from two directions confronting each other and the forging effect is confined to the narrow parts between both operating surfaces of upper and lower external forces and a mandrel inserted in the material. All of the other parts are free from the forging effect. In consequence, the hollow metallic materials must be forged repeatedly from many directions so that nearly a uniform forging effect can be given from all the directions to the axis of the material to be worked up. By such means, it is absolutely necessary to select an expert technique and to spend a long period of time to make the forging effect uniform and to complete the operation at the required size and shape of the material. And yet, it is far from possible that any forged product of precise shape can be obtained even after the completion of such operation.

The forming of hollow metallic materials, especially thin pipe-shaped materials, have been effected mainly by the Pilger Roll Mill or Plug Mill Process heretofore.

In such cases, however, the forging effect can not be given uniformly all over the whole circumference of the material even by virtue of various technique, as the rolling external forces act always only from two directions confronting each other. And also no uniform effect of forging is entailed by the Continuous Mill Process, in which several pairs of vertical and horizontal rollers are alternatively arranged, so as to pass the material among them.

There is the Drawing Process by means of dies, in accordance with which the hollow metallic material is kept in close contact with the entire circumference of a mandrel inserted into the hollow space of the material, and the whole surface of the material can be subjected to a uniform effect of external deforming forces. This process is, however, not only very far from efficient, but also there is usually a drawback that it can be hardly adopted for such materials as high carbon steels or other alloy steels of low tensile strength.

In the same way, according to the Push Bench Process, the metallic material is always susceptible to enormous impulses when passing through each of the rings. And as the shape of the operating surface of each ring is conical, the operating external forces do not act vertically on the axis of the metallic material, but they are generally accompanied by a pulling force in the longitudinal direction, so, the working up of uniformly thin pipes is rendered almost impracticable.

In the case of increasing the operating degree in the prior arts of operation by means of the Cross Roll, this operation used to lead to spurring a discord of the circumferential speeds at all contact points between the rollers and the material to be worked up, thus causing the entailment of torsional strain in the material, and the torsional external forces which have a component of force in the longitudinal direction to cause the forwarding of the metallic material used to act in such a manner as being concentrated peculiarly on the surface of the material, thus tending to damage the quality of material very often.

In contradistinction to the aforesaid means, the present invention offers an advantageous process, by which the whole cylindrical surface of the hollow metallic material can be tightened and compressed always by the external forces from all directions perpendicular to said surface, where by such drawback as mentioned above is eliminated and thus forged or worked up products can be manufactured without any technique readily in a short period of time and moreover their automatic production becomes possible.

Namely, the invention relates to a process for rotary forging a hollow metallic material, or working it up to formation, which comprises in causing said material with a mandrel inserted in the center to be gripped and revolved by means of several rollers in uniform rotation of the same direction at symmetrical positions according to the central axis of the material, moving the rollers by parallel pressure in direction of the central axis of the material to be worked up and tightening it from all directions prependicular to its whole cylindrical surface, thereby imparting a uniform forging effect on the material between the rollers and mandrel provided therein already mentioned.

According to the present invention, every part of the hollow metallic material is revolved at entirely or preferably the same circumferential speed by means of a group of same shaped rollers, all of which are driven in uniform rotation of the same direction. Accordingly the forg-

ing effect entailed thereby is given on each part of the material uniformly.

Although the operating surface of the group of rollers, in this case, is in linear contact with the material, the effect of this linear contact apparently results in a surface contact i. e. the linear contact is integrated, from the view point of the material, as it is being revolved by means of the rollers during the operation. Consequently the forging effect acts not only uniformly on the metallic material in the longitudinal direction, as mentioned above, but also it is given all in the same manner from all circumferential directions perpendicular to the surface of the material.

So, the molecular structure of the hollow metallic materials scarcely subjected by torsional strain. That is to say, the above mentioned treatment led to no destruction of the arrangement of the particles in the forging and elongating direction towards the inner part of the hollow metallic material.

As the above mentioned operation is carried out simultaneously with the rotation of the material, it is momentarily given between one of the rollers and the mandrel a slight extent of permanent deformation by means of contact with the rollers, and in an instance, it is freed from this external forging effect, and subjected to the next roller for the repetition of permanent deformation for a moment.

Therefore, this uniform forging effect becomes a continuation of momentary forging for each part of the metallic material as if it were subjected to hammering and it is given an effective forging or forming treatment in a comparatively short period of time. In addition, this operation may be carried out to any required extent. Moreover, it holds good theoretically as well as practically that the quality of the material can be extremely improved, due to the fact that the aforesaid operation is distributed always over the entire surface of the material and its operating surface is thus remarkably increased. By means of this operation and effect, this process shortens the duration of operation and enables the mass production of the excellent manufactures.

As mentioned above, the hollow metallic material can be forged or worked up advantageously by means of a group of cylindrical rollers of their axes are parallel to one another, and at the same time, as for the rollers of this invention may be provided suitably crossed ones and the forming passage made by them is rendered cylindrical thereby the material is compressed conveniently by means of a tightening movement of said forming passage and a feeding movement due to the cross angle of said rollers, thus enabling the diameter of the material to be compressed up to any required sizes.

When the forming passage shaped by these rollers in this case, caused to consist of a conical and a cylindrical part contiguous to each other, and the metallic material guided in from the side of the larger diameter of the conical forming passage, it will be given a forwarding movement by means of friction of its contact surface with the rollers, and simultaneously it is gripped firmly to the rollers by means of a tightening movement of the forming passage, so that the metallic material can be pressed forwards in the direction of the cylindrical part of the forming passage. The hollow metallic materials forwarded into the cylindrical forming passage will be compressed by means of a tightening movement of the forming passage by the rollers, and further promoted by means of a feeding movement due to the cross angle of the rollers, so that the material can be elongated up to the required diameter.

As is explained above, when the rollers are crossed to each other, the working up of the metallic material has been carried out nearly by the tightening movement of the forming passage only. Such being the case that the amount of a draft of the rollers can be exceedingly enlarged, and at the same time, the rolling external forces act strongly into the inner part of the material, as the resultant force, consisting of the forwarding force acting in the tangential surface entailed by the friction of the contact surface of the rollers and the material, and of the tightening force entailed by the squeezing movement of the forming passage, the latter being at right angles to the former one, i. e. in the direction of the radius of the material.

In this manner, such case are entirely eliminated as the surface of the metallic material only is strongly elongated, as is often the case with the Cross Roll Mill heretofor.

Thus the inner part of the metallic material can be acted by the tightening and forwarding forces as uniform as the surface of the material. As the matter of fact, the quality of the metallic material can not be damaged, and the hollow metallic material with a mandrel inserted therein can be elongated as being kept in such close contact with the latter that extremely thin pipes can be readily worked up.

Fig. 1, shows a front elevation of two rollers and the hollow metallic material with a mandrel inserted therein.

Fig. 2 shows a side elevation of provided three rollers with three larger driving rollers.

Fig. 3 shows a front elevation of two rollers crossed to each other.

Fig. 4 shows a front elevation of a cross roll, which working surfaces consisting of two forming passage.

Fig. 5 shows a diagram of working steps, according to the cross roll of Fig. 4.

In Fig. 1 illustrating an example for working up of forging a hollow metallic material by means of the cylindrical rollers, as embodied in the present invention. Namely, parallel to the axis of the material are provided the rollers **2** and **3** having a larger diameter than that of the material **1** with a mandrel **5** inserted therein and a longitudinal length greater than that of the material **1** in its completed state after the operation. These rollers are forced a parallel movement in the direction P of the axis of the material by some appropriate means, for instance, hydraulic pressure or of transmission gears.

In the case of many rollers should be employed, it is better to transmit the motive force from the driving rollers **7**, **8** and **9** of larger diameter to the operating rollers **10**, **11** and **12** of smaller diameter, as shown in Fig. 2.

As it is advantageous to employ too lengthy operating rollers, in a case of forging of remarkably long or massive materials, the material should be inserted into the forming passage from one end of the material and the working up of it has to be repeated by feeding the material to the other end, under the same condition of works of the rollers, thereby enabling lengthy material uniformly and easily.

As for another example, this invention will be carried out effectively by using crossed rollers,

In this case, it is necessary to constitute the rollers 13 and 14 in the shape of huperboloid as shown in Fig. 3 and the forming passage thus shaped is rendered cylindrical. By these rollers, the material is compressed by means of tightening movement P of the forming passage, and it is caused to move in the direction of Q due to the cross angle of the rollers. Accordingly, the material can be readily elongated by repeating compressing movement of the forming passage.

In the case of employing Cross Roll, it is possible to carry out the elongating operation of the material very logically by constituting the rollers, so as to consist of a conical and cylindrical part contiguous to each other, as shown in Fig. 4 and Fig. 5.

The forming passage is caused to take the position of A B C C' B' A' and D E F F' E' D' alternatively, due to the tightening movement of the rollers. In this manner, the hollow metallic material 1 guided into the forming passage is revolved in the direction of N, and it can be elongated to the required diameter between the mandrel 5 and rollers 14' and 15, while it is being fed in the direction of Q due to the cross angle of the rollers.

Namely the material placed in the conical forming passage A B B' A' (G B B' G'), formed by the surface 16 and 17 of the rollers 14' and 15, can be tightened uniformly from all directions perpendicular to the axis of the material and pressed forth towards the cylindrical forming passage, while the conical forming passage I is tightened up to D E E' D'.

Subsequently, the metallic material is not given any influence in the period during which the conical forming passage I is expanded up to the position A B B' A' but forwarded only the distance EH by the feeding force in the direction of the axis of the material due to the cross angle of the rollers. In the case when the speed of expansion of the forming passage, that is the movement of the rollers direction R, is small, by the said frictional feeding force forwarded material is hindered by the surface of the rollers 16 and 17, so that the material also during this period might be gripped and elongated by this part of rollers, and forwarded more than the distance EH.

Therefore, this conical forming passage I serves to grip and press forward the material to be worked up to the second step of operation.

The metallic material now coming into the cylindrical forming passage shaped by the surfaces 18 and 19 of the rollers 14' and 15, can be elongated only in the period during which the forming passage B C C' B' is tightened up to the position E F F' E', whereby the material is pressed and elongated the distance HJ, simultaneously pressing forwards by the movemental force from the conical forming passage part I, then the elongating working up of the material is brought to completion at this elongating part II.

Subsequently, the metallic material is prevented from any more deformation than up to the required diameter at the lapping part III.

In this example, to shape the forming passage as shown in Fig. 5, the shape of the rollers 14' and 15 are not limited to as shown in Fig. 4. It varies, naturally, according to the quality of the material, the amount of draft, and the cross angle. Furthermore, it is suitable to connect the conical and the cylindrical forming passage by an intermediate curved surface, continuous to both surfaces 16 and 18, and 17 and 19.

To working up the material, especially thin hollow pipe, it is better to select a smaller cross angle of the rollers, decrease the unit draft of the material by the rollers, and increase the running speed of the rollers. By these way, such hollow metallic material can be elongated with high efficiency and any damage of the quality of the material will be prevented. In this case, the increased gyrating inertia of the material, due to the high running speed, brings the effect of preventing the formation of prejudised thickness of the material during the working up.

To enforce this invention, it is preferable to improve the quality of the hollow metallic material by the rotary forging caused by the cylindrical rollers as shown in Fig. 1, and then elongated to the determined diameter by the cross rollers as shown in Fig. 3 and Fig. 4.

As mentioned above, the operation of the present invention is accurately depended on a mechanical manner, namely, the relation between the variation of the running speed of the rollers and the speed of the tightening movement of the forming passage, or the other words, the operating degree of the hollow metallic material to be worked up. Therefor, it is possible to keep the operating degree, operating time and the size of product at definite values very easily to the utmost, and also to retain the finishing temperature of the products at always the desired degree, so that the growth of metallic crystalline grain of the material can be extremely restrict and the working up of the product of excellent quality completed readily.

Accordingly, by the manufacturing process of the invention has an effect of enabling forged or formed products with uniform extents of operation and uniform shape in mass production under perfect automatic operation by employing a determined size of material.

Moreover, owing to these features, without any expert technique, it is possible to obtain products of high carbon steels or other alloy steels of various kinds easily and automatically, the manufacture of which requires especially limited working temperatures and extents of operation and other complicated conditions.

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