O. BRIEDE.

METHOD OF MANUFACTURING SEAMLESS TUBES.

APPLICATION FILED FEB. 15, 1910.

974,744. Patented Nov. 1, 1910.

2 SHEETS—SHEET 1.

FIG. 1.

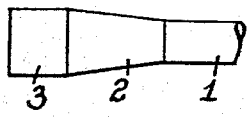


FIG. 3

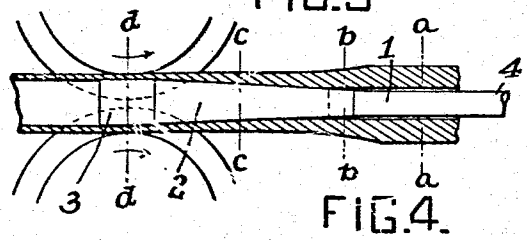


FIG. 2.

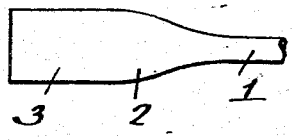


FIG. 4.

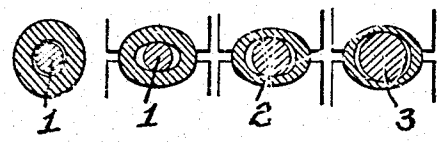


FIG. 5.

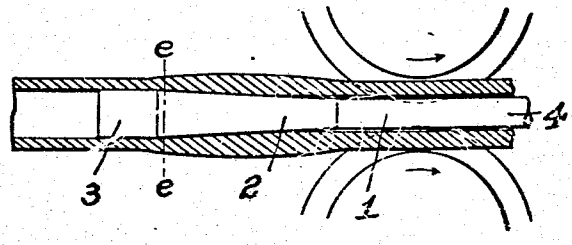


FIG. 6.

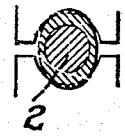


FIG. 8.a

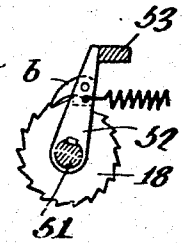


FIG. 7.

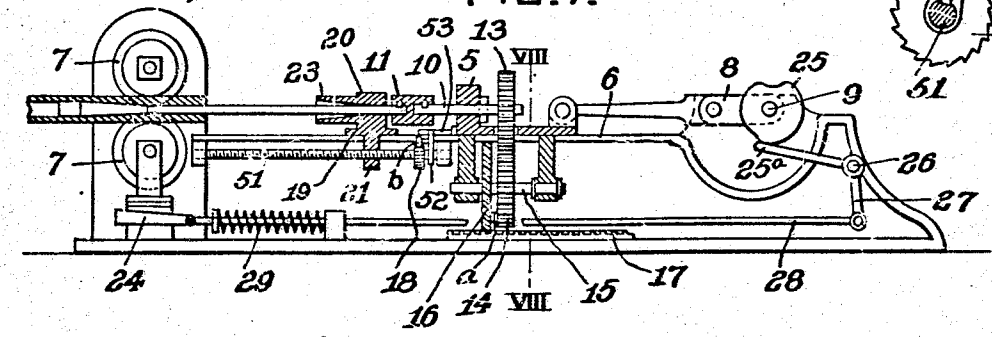


FIG. 8.

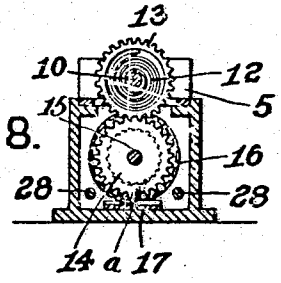
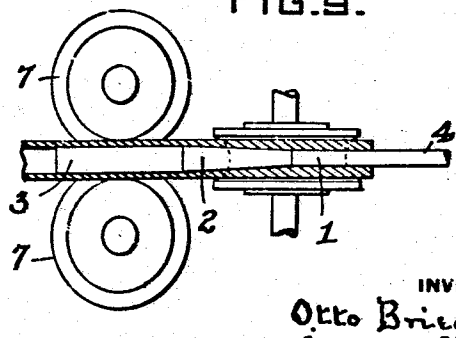


FIG. 9.



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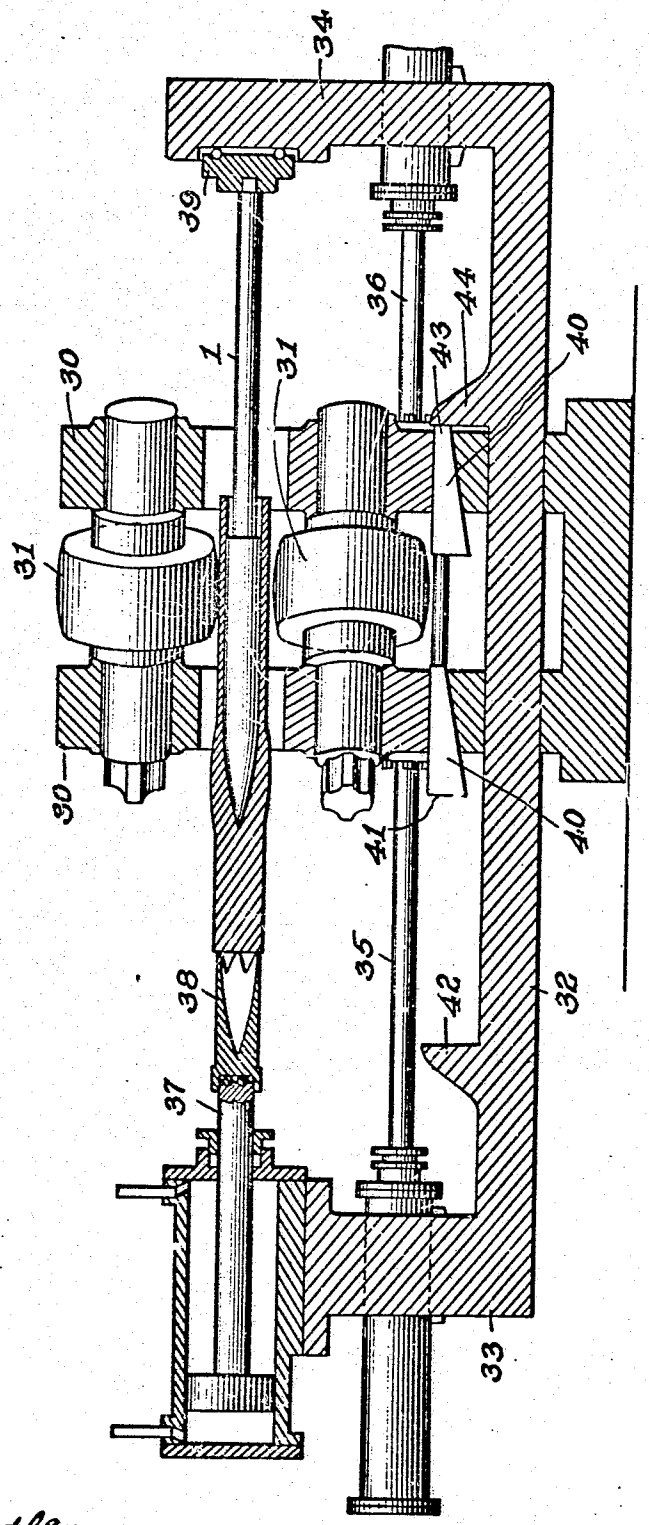

FIG. 10.

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METHOD OF MANUFACTURING SEAMLESS TUBES.

974,744. Specification of Letters Patent. Patented Nov. 1, 1910.

Application filed February 15, 1910. Serial No. 544,082.

To all whom it may concern:

Be it known that I, OTTO BRIEDE, residing at Benrath, near Dusseldorf, Province of the Rhine, German Empire, a subject of the German Emperor, have invented or discovered certain new and useful Improvements in Methods of Manufacturing Seamless Tubes, of which improvement the following is a specification.

Heretofore in reducing hollow billets to tubes, the billet was made of an internal diameter corresponding approximately to that desired in the finished tube, but the external diameter is made greater than that of the finished tube. And reduction is effected by subjecting the external surface of the billet to reducing surfaces of progressively reduced caliber. In other words, during reduction from billet to tube, the internal diameter of the former remains practically unchanged while the external diameter is reduced.

The invention described herein has for its object the reduction of a hollow billet to tube form by increasing the internal diameter of the billet, without decreasing the external diameter of the finished tube materially beyond the original external diameter of the billet.

The invention is hereinafter more fully described and claimed.

In the accompanying drawings forming a part of this specification Figures 1 and 2 show in side elevation different forms of mandrels, Fig. 3 is a diagrammatic view illustrating my improved method. Fig. 4 shows transverse sections in planes indicated respectively by *a*—*a*, *b*—*b*, *c*—*c*, and *d*—*d*, Fig. 3; Fig. 5 is a view showing the position of the billet and mandrel at the beginning of a forward or working stroke and after the rolls have been separated and the mandrel and billet turned axially ninety degrees; Fig. 6 is a transverse section in a plane indicated by the line *e*—*e* Fig. 5; Fig. 7 is a view partly in section and partly in elevation of a form of apparatus adapted to the practice of my invention; Fig. 8 is a transverse section in a plane indicated by the line VIII—VIII; Fig. 8ª is a sectional detail view illustrating a portion of the feed mechanism. Fig. 9 is a diagrammatic view illustrating the employment of a plurality of pairs of rolls and Fig. 10 is a sectional view of another form of mill adapted to the practice of the invention and Fig. 11 is a sectional plan of the same.

In the practice of my invention, the billet is rolled or otherwise reduced to a diameter equal or approximately equal to the external diameter desired in the tube to be formed. After the billet has been pierced, which however is not necessary, it is slipped onto a mandrel 1 having a portion of the end enlarged and conical as at 2 and an adjacent portion 3 cylindrical and of a diameter equal to the desired internal diameter of the finished tube. The portion 2, which may be of any suitable form as for example a cone with straight sides as shown in Fig. 1 or a paraboloid as shown in Fig. 2, connects the stem 4 of the mandrel with the cylindrical portion 3. It is preferred that the cylindrical portion should be given a slight taper from or approximately from the plane of junction of the portions 2 and 3, so as to facilitate the movement of the finished portions of the tube off of the cylindrical finishing portion of the mandrel.

After the billet has been slipped on the mandrel the stem 4 of the latter is connected to a suitable mechanism for reciprocating it and after each reducing movement, imparting a partial rotation to the mandrel. A suitable form of such mechanism consists of a slide 5 mounted on a bed 6 which is arranged in feed relation to the reducing rolls 7. This slide is connected to a crank arm 8 of the shaft 9 which can be rotated by any suitable means. A connecting shaft 10 is rotatably mounted on the slide and is provided with a suitable coupling member 11 whereby it may be connected to the stem of the mandrel as shown in Fig. 7. Any suitable means may be employed for rotating the mandrel and billet as for example one end of a clock spring 12 may be attached to the shaft 10 and its opposite end to an externally toothed shell 13 engaging a pinion 14 loosely mounted on a shaft 15, on which is loosely mounted a pinion 16 having angularly arranged teeth adapted to engage inclined teeth on a stationary rack bar 17. The shaft 15 is mounted in suitable brackets depending from the slide 5, and it reciprocates with the latter. Therefore when the slide is reciprocated corresponding back and forth rotation will be imparted to the pinion 16. When the pinion is rotated in one direction *i. e.* during a

working or reducing stroke of the slide it is operatively connected to the pinion 14 by a suitable pawl and ratchet device *a* thereby rotating the toothed shell 13 and placing the spring under tension, which will become operative to rotate the mandrel and billet as soon as the latter is released from the grip of the rolls at the end of the working stroke. During the return stroke of the slide the toothed shell will not be rotated. Provision is made for forcing the billet farther in the mandrel at the end of the reducing stroke of the latter. A convenient means to this end consists of a ratchet disk 18 keyed to a screw threaded spindle 51 mounted for rotation in suitable bearings of the frame of the machine. The pawl *b* of the said ratchet disk is disposed on a rocker arm 52 mounted on the spindle 51. A finger of the said rocker arm is adapted to be engaged and to be rocked by a cam face 53 provided on the slide 5 whenever the latter reaches the end of its return stroke. By the pawl *b* such rocking movement is transmitted to the ratchet disk 18 and the spindle 51. When released from the said cam the rocker arm is retracted into its normal position by a spring. The shaft 51 is threaded and engages a threaded opening through a downwardly projecting lug 21 on a slide 19 which is provided with a wall or abutment 20, adapted to bear against the rear end of the billet. In order that the whole of the billet may be reduced, a sleeve 23 is interposed between the rear end of the billet and the abutment, said sleeve being preferably integral with the abutment 20 and made of a length a little greater than that of the conical portion of the mandrel and of such internal shape and dimensions that such conical portion may enter the sleeve. The abutment 20 is advanced toward the mandrel whenever the slide reaches the end of its return stroke. In order that the billet may be turned axially after each forward movement, provision is made for relieving the exterior surface of the billet of any retarding frictional resistance of the rolls. This can be accomplished in many ways, as by using recessed or sectional rolls or swages, well known in this art, or by separating the rolls a sufficient distance to permit of the free movement of the billet axially and longitudinally.

As shown in Fig. 7 provision is made for shifting one of the rolls toward and from the other by means of wedges 24 movable under the journal boxes of the lower roll. These wedges should be shifted to drop the lower roll at or about the time the billet and mandrel reach the limit of their forward or reducing movement. At or about the time the mandrel reaches the limit of its return or non-working movement, the lower roll is again raised to its operative or reducing position. These movements of the wedges to raise the roll are effected by any suitable means, as for example by a cam 25 on the shaft 9 acting on an arm 25[a] on a counter shaft 26 which is provided with arms 27 connected by rods 28 to the wedges, which are shifted in the opposite direction to drop the lower roll by springs 29 or other suitable means.

In describing the method as carried out by the construction shown in Figs. 3 to 8 inclusive, it will be understood that a reduction has been completed by the rolls and that the latter and the billet and mandrel are in the position shown in Fig. 3. During such reduction the billet has been caused to assume the transverse relations to the mandrel shown in Fig. 4, by the rolls which are provided with grooves forming an oval pass, so as to avoid finning of the metal. As soon as the several parts reach the position shown in Fig. 3 the billet is released from the bite of the rolls by dropping the lower roll, and the rear end of the billet strikes against the shiftable abutment 23, so that it is slipped farther on the mandrel. This action is facilitated by the oval shape of the billet imparted thereto by the previous reducing operation. By this movement of the mandrel into the billet the latter is enlarged peripherally along that portion in contact with the conical portion of the mandrel as indicated in Fig. 5. Furthermore the turning mechanism is thrown into operation, and turns the billet at an angle of 90 degrees, whereupon the mandrel and billet perform their return movement to the left. At the end of their return movement the billet and mandrel are moved forward or in a direction to cause a reduction of the portion of the billet enlarged by the mandrel, the metal displaced in such reductions causing an elongation along the portion operated on. As before stated the grooves in the rolls are so shaped as to form an approximately oval pass or of such shape and dimensions relative to the tube to be produced that the upper and lower walls of the pass will act reductively on about one quarter of the perimeter of the billet; and as the billet at the beginning of each reduction is circular or approximately so in cross-section the pressure of the rolls will cause not only a longitudinal flow of the metal but also and to a limited extent a lateral flow so that the side portions of the billet will be forced away from the mandrel. After a reducing movement of the billet and mandrel or one to the right in Figs. 5 and 7, the billet is relieved of the pressure of the rolls, the billet and mandrel are turned through an arc of 90° to the position shown in Fig. 6, and the mandrel and billet moved relative to each other so as to cause an enlargement of a portion of the billet for a distance ap-

proximately equal to the length of the conical portion of the mandrel.

It will be observed that two reducing elements are employed *i. e.* the mandrel and the grooved rolls or swaging or reducing members. It is immaterial which of these, the mandrel or rolls, is moved relative to the other. In addition to the reducing elements, a feeding movement of the billet relative to the mandrel is effected intermediate of billet reducing operations. The rolls while reducing the billet should have a peripheral movement corresponding to the rectilinear movement of the billet and this movement of the rolls may be effected in any suitable manner, as for instance by contact with the surface of the billet. As shown in Fig. 9 a plurality of pairs of rolls may be employed, successive pairs of rolls being arranged with their axes at an angle to the axes of adjacent rolls. When using a plurality of pairs of rolls the billet need not be turned axially and if a sufficient number of pairs be employed a billet may be reduced to tube form by a continuous movement through a single train of rolls.

In Fig. 10 is shown a mill adapted to the practice of the improved method and having the rolls rotating in a plane at an acute angle to the axis of the mandrel, whereby the path of the rolls on the billet can be of any desired length by changing the angular relation of the rolls to the axis of the billet. In this construction the rolls are positively driven in such direction as to travel in a spiral path from a point adjacent to the point of the conical portion of the mandrel to the cylindrical portion thereof, and to this end provision is made permitting a movement of the mandrel carrying the billet and the rolls relative one to the other. In the construction shown, the housing 30 in which the rolls 31 are mounted with their axes at an angle to each other and to the axes of the mandrel 1, is stationary while the bed 32 carrying the mandrel and the billet feeding means is movable relative to the rolls. In the construction shown the bed 32 is provided at its ends with vertical abutments 33 and 34 which carry fluid pressure cylinders so arranged that their rams or pistons 35 and 36 bear against opposite sides of the housing 30. By means of suitable valve mechanism such as is well known in the art the flow of fluid pressure to and from said cylinders is regulated to effect any desired movement of the bed and parts carried thereby relative to the rolls. A fluid pressure cylinder and piston 37 are so mounted on the abutment 33 as to be capable of forcing the billet into the mandrel which is held as against longitudinal movement during such feed by the abutment 34. In order to permit of the easy rotation of the mandrel and billet by the rolls antifriction thrust bearings 38 and 39 are interposed between the piston rod and billet, and between the mandrel stem and abutment.

Any suitable means may be employed for releasing the billet from the grip of the rolls at the end of the reducing stroke and during the return or dead stroke. In the construction shown wedges 40 are employed for shifting the lower roll. The end 43 of one of the wedges strikes against and is shifted by a stop 44 at the end of the working stroke thereby permitting the lower roll to drop and at the end of the return or dead stroke or movement the face 41 will strike the abutment 42 and shift the wedges in a direction to cause the rolls to assume normal or operative relation to the billet.

In the mill shown in Fig. 10 the rolls will cause a reduction of the portion of the wall of the billet forced by the action of the mandrel substantially as before stated. By arranging the rolls as in Fig. 10 the conical portion of the mandrel may be made of considerable length without unduly increasing the size of the rolls. After the completion of a working or reducing stroke the billet is released from the grip of the rolls, and the mandrel and billet are returned to initial position and during this movement the billet is advanced on the mandrel by means of the cylinder and piston 37. As is well known in the art the axial rolling of the billet has a tendency to open up the metal adjacent to and along its axis thereby facilitating the penetration of the mandrel into the billet at each feed movement.

While for convenience of illustration and description it has been set forth with some particularity that after expansion the billet is reduced to or approximately to original external dimensions the invention is not so limited as regards the broad claims as the extent of reduction after expansion may vary being largely dependent upon the thickness of wall in the finished tube.

I claim:

1. The method of manufacturing seamless tubes, which consists in increasing the internal and external dimensions of the billet and then as a part of the same operation reducing the external dimensions of the same.

2. The method of manufacturing seamless tubes which consists in alternately and successively increasing the internal and external dimensions of a billet and reducing the external dimensions thereof.

3. The method of manufacturing seamless tubes which consists in progressively increasing the internal and external dimensions of a billet and progressively as a part of the same operation reducing its external dimensions.

4. The method of manufacturing seamless tubes which consists in enlarging the exter-

nal dimensions of a billet by a radially acting force and then as a part of the same operation reducing the external dimensions.

5. The method of manufacturing seamless tubes which consists in progressively step by step increasing the internal dimensions of a hollow billet and then step by step reducing the thickness of the wall of the billet while maintaining the increased internal dimensions.

6. The method herein described which consists in subjecting a billet to oppositely acting radial forces, said forces operating alternately and progressively along the billet.

In testimony whereof, I have hereunto set my hand.

OTTO BRIEDE.

Witnesses:
HENRY HASPER,
WOLDEMAR HAUPT.