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METHOD OF PRODUCING TUBULAR
METALLIC BODIES

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This invention relates to a method of producing hollow or tubular bodies of steel or other metals from "bottles" or hollow billets with closed ends.

In some methods such a "bottle" or hollow billet is formed by driving a mandrel or punch into a solid billet supported in a die or mold, the section of billet and die or mold being such as to provide space in the mold to receive the metal displaced by the mandrel or punch whereby there is formed a substantially cylindrical "bottle" or hollow billet which is then removed from the die or mold and pushed by an inserted mandrel or arbor through dies or draw rings to increase the length and reduce the wall thickness of the tubular portion.

One feature of the present invention consists in forming a tubular body from a centrifugally cast hollow billet which has a closed end and is of increasing diameter from its closed end. The exterior wall of the hollow billet may be of increasing diameter over its entire length or may be of increasing diameter from its closed end for part only of its length, the remaining portion being parallel. Such a cast tapering billet may be formed by casting in a tilting centrifugal casting machine.

A further feature consists in expanding and shaping the tapering closed end portion of such a billet by forcing a mandrel or arbor into the billet while it is supported in a mold or pot of the desired length and form with the tapering closed end of the billet bearing against the closed end of the mold, the tapering end portion of the billet being thus forced into conformation with the mold. The mold may be cylindrical with a hemispherical closed end, while the arbor may be slightly tapered to facilitate withdrawal and have its end shaped to correspond with the mold end.

A further feature consists in contracting and elongating the wall of the remaining portion of the partly formed tubular body by causing movement of the body and the inserted arbor relatively to an encircling die or drawing ring while the closed end portion of the body is still contained in and supported by the mold, or the mold may be removed after the closed end of the billet has been shaped.

Referring to the drawing,

Figs. 1, 2, 3 and 4 are vertical sections showing diagrammatically, in various stages, an arrangement of apparatus for forming tubular bodies according to the present invention;

Fig. 5 is a sectional elevation of a modified ar-

range ment for holding and releasing the mold.

In the embodiment of the invention illustrated in the drawing, a mold 1 of the desired size and shape is held, as by a stop or abutment 2, in alignment with a drawing die or ring 3 on a stationary support 7 and a power operated mandrel or arbor 4 beyond.

The stop 2 is shown in Figs. 1-4 supported on a rod 20 which extends from a piston 21 within a cylinder 22, to the upper or lower ends of which a liquid under pressure may be admitted from a supply pipe 23 through valve 24 and conduits 25 or 26. 27 is an outlet pipe with which conduits 25 or 26 may be connected through the valve 24. 28 is a valve actuating lever.

40 designates a piston with which the arbor is connected. 41 is a cylinder surrounding the piston 40. Hydraulic pressure may be admitted to or withdrawn from the cylinder 41 by means not shown.

The tapered billet 5, the closed end 5^a of which may, as shown in Fig. 1, be thickened and shaped somewhat like the nose of a projectile, is placed in the mold after being cleaned and heated, its closed end bearing against the closed end of the mold and its larger end portion extending beyond the drawing die or ring 3 with which it preferably makes even contact. The mandrel or arbor 4 is then advanced into the billet, (Fig. 1) first contacting with its interior practically at the position of the drawing die or ring and thereafter expanding the tapering end 5^a of the billet into conformation with the mold, as shown in Fig. 2, any metal exceeding that filling the space in the mold being caused to flow through the space between the mandrel or arbor 4 and the drawing die or ring 3, thus elongating the billet. The advance of the mandrel or arbor for this purpose having been stopped or completed, the stop or abutment 2 is withdrawn or released and advance of the mandrel or arbor continued, (Fig. 3) so that the mold 1 is either carried forward on the nose of the partly formed body, or removed, as shown at 1A in Fig. 3, and the tapering portion of the billet 5 is pushed through the drawing die or ring 3, thus contracting and elongating the wall of said tapering portion so that it conforms internally to the mandrel or arbor 4 and is parallel sided externally. After the body has cleared the drawing die or ring (Fig. 4), a stripping plate 6 is positioned to straddle the mandrel or arbor between the drawing die or its support 7 and the end of the body 5 and the mandrel or arbor 4 then drawn back, thus stripping the body from it.

The cylinder 22 may be larger than cylinder 41 so that if piston 21 is actuated by the same pressure as that which actuates piston 40, piston 21 will be held against a stop 29 to position mold 1, with a greater force than that which moves arbor 4.

The movement of arbor 4 may be used to relieve the pressure under piston 21 when the arbor reaches the desired position relative to mold 1, by some such arrangement as that shown diagrammatically in Figs 1-4. 42 is an arm affixed to arbor 4. A rod 43 extends through this arm and through valve actuating lever 28 and carries buttons 44 and 45 which are adjustably positioned on it. The movement of rod 43 will cause button 44 to engage lever 28 and move it from the position in which it is shown in Figs. 1 and 2 to the position 28A in which it is shown in Figs. 3 and 4. In Figs. 1 and 2 the pressure supply pipe 23 is shown connected through valve 24 and conduit 26 with the part of cylinder 22 below piston 21 and the other end of cylinder 22 connected through conduit 25 and valve 24 with outlet pipe 27. In Figs. 3 and 4 these connections are reversed to move piston 21 and mold 1 away from the end of body 5.

As arbor 4 continues to move after mold 1 is withdrawn, the rod 43 is arranged to slide through arm 42, stops 46 and 47 being provided on the arm and a spring 48 interposed between the arm 42 and the stop 47 of sufficient strength to actuate the valve. The opposite movement of rod 43 will cause its button 45 to engage lever 28 and reverse the valve to return mold 1 to its operative relation to arbor 4.

A simple arrangement for holding stop 2 and tripping its support by the movement of the arbor is illustrated diagrammatically in Fig. 5. In this case a rod 43A which moves in unison with the arbor engages a part 50 of a latch member 51 which is pivoted at 52 when the arbor reaches the point in its travel illustrated in Fig. 2, to release the stop 2 and the mold 1.

Where required, a cavity 8 may, as shown in dotted lines, be formed in the closed end of the mold 1 so that metal forced into the cavity will form an end projection or boss on the body.

The exterior wall of the hollow billet beginning near the drawing ring may be parallel without departing from the spirit of the invention, the inner wall remaining tapered.

This invention enables weldless hollow or tubular bodies to be formed without great power.

A centrifugally cast billet saves metal as no "crop" is required with such billet and also the time, equipment and expense of preliminary piercing is avoided; also, such a casting comprising the initial hollow billet may be made sound and with thinner walls than can be made by punching a cavity from a solid billet.

What I claim is:

1. The method of producing a tubular body of metal which consists in expanding and shaping the end portion of a hollow billet having a tapering closed end by forcing a mandrel or arbor into the billet while said billet is supported in a closed end mold of the desired length and form in alignment with a drawing ring, with the tapering closed end of the billet bearing against the closed end of the mold, the tapering end portion of the billet being thus forced into conformation with the mold, and excess metal being extruded longitudinally between the mold, drawing ring and arbor.

2. The method of producing a tubular body of

- metal which consists in centrifugally casting a hollow billet having a tapering closed end, expanding and shaping the end portion of said billet by forcing a mandrel or arbor into the billet while said billet is supported in a closed end mold of the desired length and form in alignment with a drawing ring, with the end of the billet bearing against the mold, the end portion of the billet being thus forced into conformation with the mold, and excess metal being extruded longitudinally between the mold, drawing ring and arbor.

3. The method of producing a tubular body of metal which consists in expanding and shaping the end portion of a centrifugally cast billet having a tapering closed end, with its end having less area than the interior of the mold into which it is to be forged, by forcing a mandrel or arbor into the billet while said billet is supported in a closed end mold of the desired length and form beyond and in alignment with a drawing ring, with the end of the billet bearing against the end of the mold, the end portion of the billet being thus forced into conformation with the mold and further movement of the mandrel or arbor causing any excess metal in the billet end to move through and beyond the drawing ring, unconfined by walls beyond the drawing ring.

4. The method of producing a tubular body of metal which consists in expanding and shaping the end portion of a centrifugally cast billet having a tapering closed end, with its end having less area than the interior of the mold into which it is to be forged, by forcing a mandrel or arbor into the billet while said billet is supported in a closed end mold of the desired length and form beyond and in alignment with a drawing ring, with the end of the billet bearing against the mold, the end portion of the billet being thus forced into conformation with the mold, and excess metal being extruded longitudinally between the mold, drawing ring and arbor and further movement of the mandrel or arbor causing any excess metal in the billet end to move through and beyond the drawing ring, unconfined by walls beyond the drawing ring.

5. The method of producing a tubular body of metal which consists in centrifugally casting a hollow billet having a tapering closed end, expanding and shaping the end portion of said billet by forcing a mandrel or arbor into the billet while said billet is supported in a concave mold of the desired length and form in alignment with and beyond a drawing ring, with the end of the billet bearing against the mold, the end portion of the billet being thus forced into conformation with the mold, and excess metal being extruded longitudinally between the mold, drawing ring and arbor and further movement of the mandrel or arbor causing the billet to move through and beyond the drawing ring.

6. The method of producing a tubular body of metal which consists of expanding and shaping the end portion of a billet having a tapering closed end and a hollow portion by forcing a mandrel or arbor between the hollow portion of the billet and a drawing ring against the closed end of the billet while said end of the billet is supported in a closed end mold of desired length and form with the closed end of the billet bearing against the mold, the end portion of the billet being thus forced into conformation with the mold.

7. The method of producing a tubular body of metal which consists of expanding and shaping

the end portion of a billet having a tapering closed end and a hollow portion by forcing a mandrel or arbor between the hollow portion of the billet and a stationary drawing ring against the closed end of the billet while said end of the 5 billet is supported in a closed end mold of desired length and form with the closed end of the billet bearing against the mold, the end portion

of the billet being thus forced into conformation with the mold and thereafter moving the mandrel and mold with the interposed formed end portion of the billet relative to the drawing ring to force the hollow portion of the billet against the mandrel.

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