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C. B. FRANCIS ET AL

2,749,609

METHOD OF FORMING HOLLOW METAL ARTICLES

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3 Sheets-Sheet 1

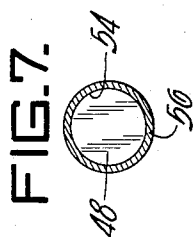
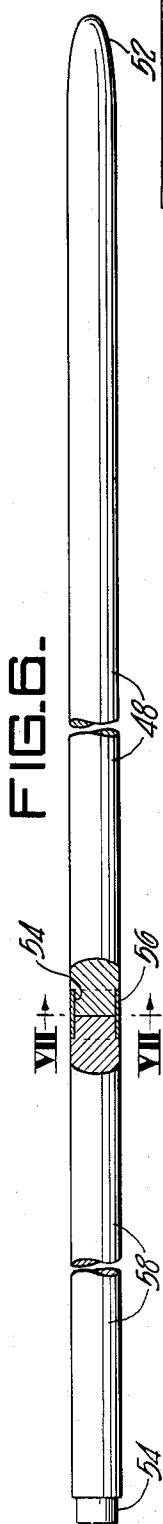


FIG. 1.

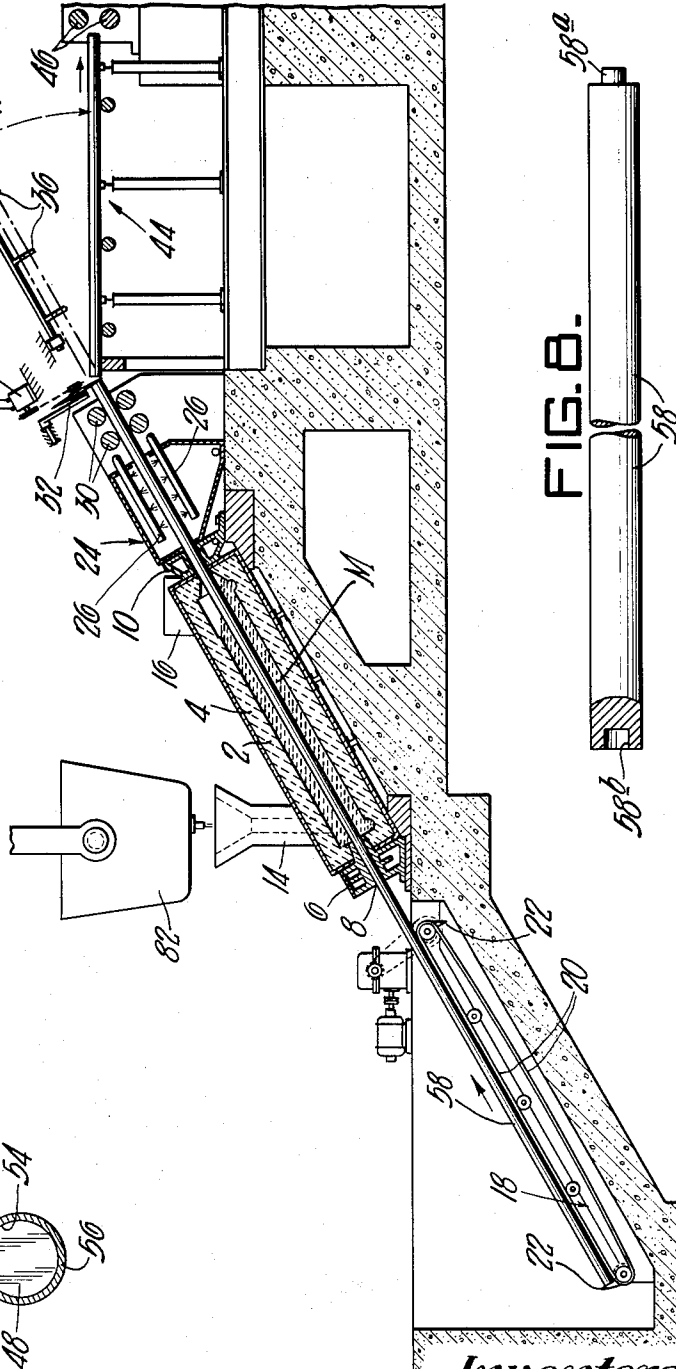
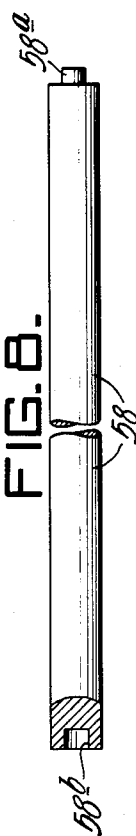


FIG. 8.



Inventors:
CHARLES B. FRANCIS and
RALPH B. PORTER,
by: *Donald G. Halton*
their Attorney.

June 12, 1956

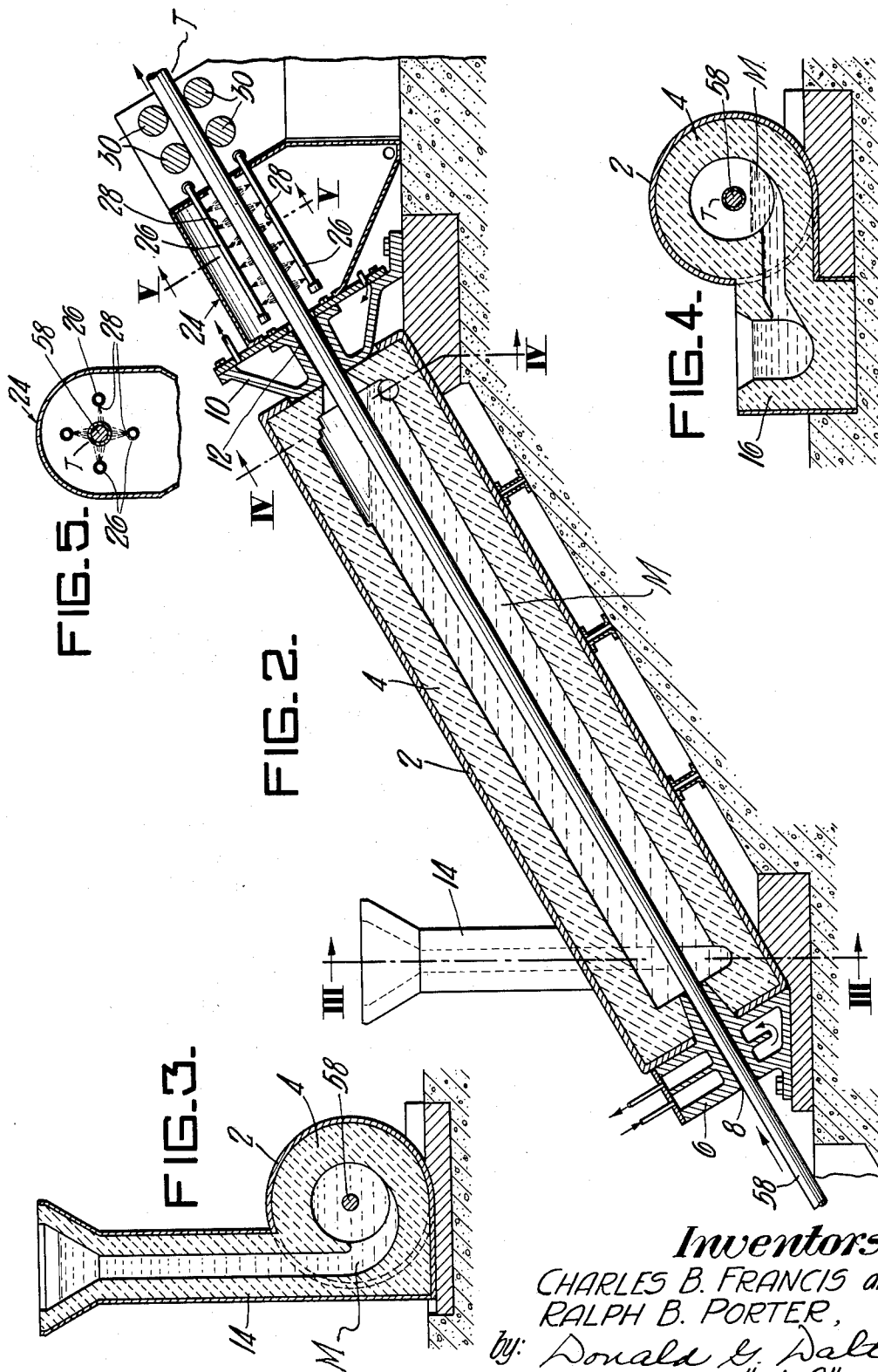
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METHOD OF FORMING HOLLOW METAL ARTICLES

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3 Sheets-Sheet 2



Inventors:
CHARLES B. FRANCIS and
RALPH B. PORTER,
by: *Donald E. Dalton*
their Attorney.

June 12, 1956

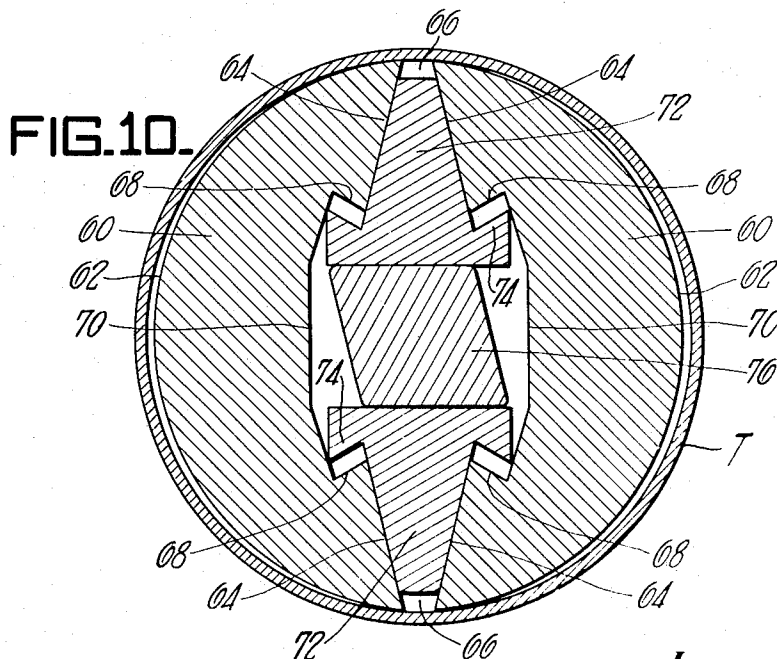
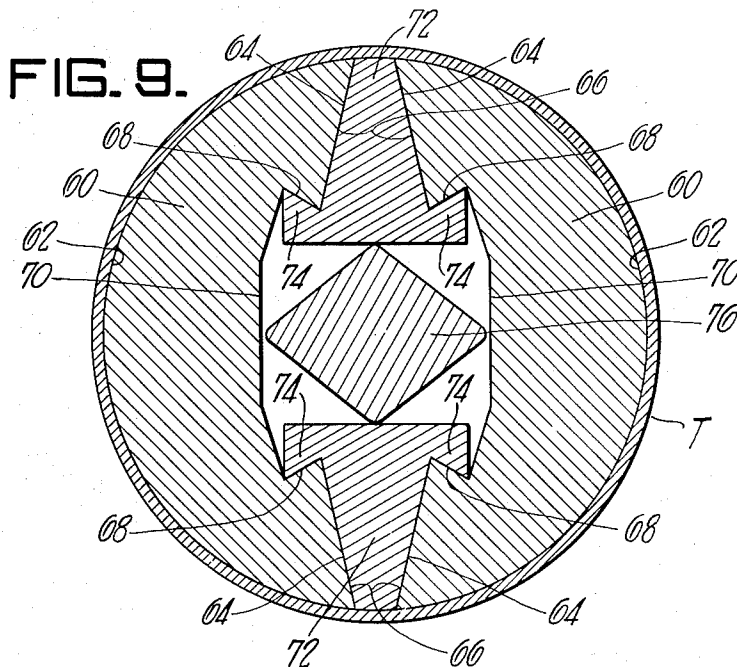
C. B. FRANCIS ET AL

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METHOD OF FORMING HOLLOW METAL ARTICLES

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3 Sheets-Sheet 3



Inventors:

CHARLES B. FRANCIS and
RALPH B. PORTER.

by: *Ronald E. Dutton*
their attorney

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2,749,609

METHOD OF FORMING HOLLOW METAL ARTICLES

Charles B. Francis, Pittsburgh, and Ralph B. Porter, Johnstown, Pa., assignors to Carnegie-Illinois Steel Corporation, a corporation of New Jersey

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4 Claims. (Cl. 29—527)

This invention relates to a method of forming hollow metal articles and more particularly to the continuous forming of hollow articles from molten steel. Various methods and apparatus have been proposed for the casting of such articles from steel, but none have proved to be entirely satisfactory. Therefore, such articles have been commonly made by bending steel sheets and joining the edges thereof by welding or by casting liquid steel into ingots, stripping the molds from the ingots, reheating and rolling the ingots into blooms, rolling the blooms into rounds, cooling the rounds, conditioning the surface of the rounds, reheating and piercing the rounds on one or more piercing mills, and subsequently subjecting the pierced round to reheating, plug and rotary rolling to form a seamless tube. These conventional methods are relatively expensive.

It is an object of our invention to provide a relatively cheap and simple process apparatus for seamless steel tubing.

This and other objects will be more apparent after referring to the following description and attached drawings, in which:

Figure 1 is a sectional view of the apparatus of our invention;

Figure 2 is an enlarged sectional view of part of the apparatus of Figure 1;

Figure 3 is a sectional view taken on the line III—III of Figure 2;

Figure 4 is a sectional view taken on the line IV—IV of Figure 2;

Figure 5 is a sectional view taken on the line V—V of Figure 2;

Figure 6 is a view, partly in section, of a former bar used in our invention;

Figure 7 is a sectional view taken on line VII—VII of Figure 6;

Figure 8 is a view, partly in section, of a modified former bar;

Figure 9 is a sectional view of a collapsible former bar in expanded position; and

Figure 10 is a view similar to Figure 9, but showing the parts of the bar in collapsed position.

Referring more particularly to the drawings, the reference numeral 2 indicates a vessel having a refractory lining 4. The vessel preferably is arranged with its longitudinal axis at an angle of 30° to the horizontal. A water-cooled guide 6 at the bottom of the vessel has an opening 8 therethrough. A water-cooled die 10 arranged at the top of the vessel has an opening 12 therein shaped in accordance with the desired outer shape of the article to be formed. The guide 6 and die 10 may be cast in one piece from a heat and wear resistant alloy steel or they may be made in two parts with the main part being of cast iron and the liner being of a heat and wear resistant alloy keyed into an opening in the cast iron. The vessel 2 is provided with two gates; a large one 14 (Figure 3) at the bottom for filling the vessel quickly, and a small one 16 (Figure 4) at the top for keeping the level

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of the metal at the desired height during the tube making process. A feed table 18 is provided at the entry end of the vessel 2 and is arranged on the same angle as the longitudinal axis of the vessel 2. The feed table has a pushing device in line with the opening 8, which pushing device consists of an endless chain 20 having fingers 22 thereon at spaced intervals. A cooler 24 is arranged above the vessel 2 in line with its longitudinal axis. This cooler may assume several forms and, as shown in Figures 1, 2 and 5, consists of four pipes 26 arranged around the outer periphery of the tube T. A plurality of openings 28 are provided in the walls of the pipes so that the water in the pipe will spray onto the tube T. A set of withdrawing rolls 30 is provided beyond the cooler 24 adjacent a quick acting cut-off machine 32 of standard construction. Beyond and above the rolls 30 is provided a trigger trough and run-out drop table 34. The drop table 34 is provided with a plurality of spaced apart fingers 36 for supporting the tube T and a trigger 39 at the outer end thereof. The trigger 39 is connected to a control 40 which will actuate fingers 36 to discharge the formed articles. A switch 41 is provided adjacent the end of the table 34 and is connected to a control 42 for starting the motor 43 of the flying shear or saw 32. A roller conveyor 44 is provided beneath the table 34. If desired, a pair of reeling rolls 46 may be provided adjacent the end of conveyor 44 for a purpose which will appear later.

When starting in operation, a former bar 48 is provided. The main part of this bar is shaped in accordance with the desired internal shape of the hollow metal article to be formed while the front part of the bar is tapered to a blunt point 52. The rear end of the former bar 48 is reduced in diameter at 54 for receiving a ring 56 which may be made of copper, brass or steel. The subsequent former bars 58 are of uniform cross section except for their ends which are reduced in diameter to receive the ring 56. In place of the ring connection 56 the forward end of the bars 58 may be formed with a projection 58a and the rear end provided with a similarly shaped opening 58b for receiving the projection. In order to facilitate removal of the former bar from the hollow metal article a composite bar may be provided as shown in Figures 9 and 10. This former bar consists of a pair of spaced apart crown sections 60 having their outer surfaces 62 shaped to correspond to the interior shape of the hollow article to be formed. The inner surface of each of these crown sections has a portion 64 which extends inwardly away from the other crown section adjacent each end of the outer surfaces so that a space 66 is provided between the crown sections which space widens as it nears the center of the bar. An under-cut portion 68 is provided on the crown sections 60 on the inner surface thereof adjacent each of the portions 64. The under-cut portion 68 of each crown section 60 is connected by a relatively straight portion 70. A wedge shaped section 72 is provided in each of the spaces 66. Each of these wedge shaped sections has a pair of projections 74 thereon which are adapted to extend into the under-cut portions 68. The inner portion of the sections 72 is straight. A diamond shaped section 76 is provided at the center of the bar. One end of this section 76 may be provided with a projection similar to projection 58a and the other end provided with an opening similar to opening 58b to receive the projection. The parts are first assembled as shown in Figure 10, the section 76 is then turned on its axis to the position shown in Figure 9 which forces the projections 74 into the under-cut portion 68 to lock the parts together.

Our method is carried out as follows:

The former bar 48 is inserted so that the end of the tapered portion is barely flush with the upper end of

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the guide 6. Liquid steel is then poured from the ladle 82 as rapidly as possible through the gate 14 until the metal M is within a few inches of the upper gate 16. The former bar 48 is then pushed through the molten metal M in the vessel 2 to the die 10. As the lower end of the former bar 48 approaches the guide 6 another former bar 58 such as shown in Figures 6, 8 or 9 is rolled on the table 18 with its lower end against a finger 22 and its forward end against the rear end of the first former bar 48. At this time the bars 48 and 58 will be positioned as shown in Figure 6. In the meantime the ladle 82 is transferred to the forward end of the vessel 2 and pouring is started through the upper gate 16. The pouring is regulated to keep the metal in the vessel 2 within an inch or two of the refractory opening to the die opening 12. As the former bar and tube T issue from the die 10 they pass through the cooler 24 and are grasped by the pinch rolls 30. From here they pass over the drop table 34 and strike the trigger 39 which actuates the control 40 to cause the fingers 36 to pivot and permit the forward end of the tube and bar to drop to a horizontal position on the conveyor 44 just as the rear end of the tube and bar emerge from the rolls. The bending of the bar closes the switch 41 which operates the control 42 to set the flying shear 32 in operation to complete the severing of the tube at the joint between bars. If solid former bars are used, the bar and tube are conveyed by means of the conveyor 44 into the rolls 46 which will loosen the tube T on the bar and permit it to be removed. If the composite former bar is used the bar is collapsed by turning the section 76 about its axis to the position shown in Figure 10. This permits the portions of the bar to collapse and be removed from the tube. In the meantime, as the end of the former bar in the vessel 2 approaches the guide 6, an additional bar is butted against it in the manner described above.

The thickness of the wall of the tube depends upon the temperature of the liquid steel M above its liquidus temperature, the speed of travel of the cold former bar, the depth of metal through which the bar passes, and the diameter of the wiper die. Ordinarily the temperature of the steel is at the usual pouring temperature, and the depth of metal and the diameter of the die are kept constant. Therefore, only the speed of the travel of the bar needs to be controlled to vary the wall thickness. The step of cooling the tube with water may be omitted, in which case the outside of the tube will be coated with a film of oxide. Instead of water, a high boiling oil, such as palm oil, may be used for cooling the tube and to prevent subsequent corrosion on the outside surface thereof.

From the preceding statements relating to control of wall thickness it is apparent that the diameter of the die must be constant and that the temperature of the metal must not be permitted to drop below its liquidus point, leaving the depth of metal and speed of the former bar the chief means of control. After the casting vessel becomes sufficiently hot, therefore, it is not necessary to keep the level within a few inches of the former die. Instead, by decreasing the speed of the former bar, the level of metal may drop to within 1 or 2 feet of the bottom of the casting vessel, thus making it possible to use practically all of the metal in a heat for forming into the hollow section desired.

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While one embodiment of our invention has been shown and described, it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

We claim:

1. The method of forming hollow metal articles which comprises inserting a relatively cold metal bar, the outside of which conforms in shape and dimensions to the inside of the article, in a bath of liquid metal, maintaining the main body of the bath temperature not below its liquidus point while the bar is in the bath, removing the bar from the top of said bath after a predetermined period of time whereby the desired thickness of metal solidifies on said bar, then immediately passing the bar with the solidified metal thereon through a stationary die which conforms in shape and dimensions to the outside of the article, cooling the metal collected on the bar, and thereafter removing the bar from the inside of said article.

2. The method of forming hollow metal articles according to claim 1 in which the metal on the bar is cooled by applying a liquid cooling medium to the outside surface thereof.

3. The method of continuously forming hollow metal articles which comprises continuously and successively passing relatively cold metal bars, the outside of which conform in shape and dimensions to the inside of the article, upwardly through a bath of liquid at such a speed that the desired thickness of metal will solidify around said bar, maintaining the main body of the bath at a temperature not below its liquidus points while the bars are in the bath, then immediately passing the bars with the solidified metal thereon through a die which conforms in shape and dimensions to the outside of the article, applying a cooling medium to the outside surface of the metal collected on the bars, severing the hollow metal articles so formed at the joints between successive bars, and then removing the bar from the severed section.

4. The method of forming hollow metal articles according to claim 3 in which the cold metal bars are collapsible and are collapsed prior to removing them from the severed sections.

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