

Feb. 2, 1937.

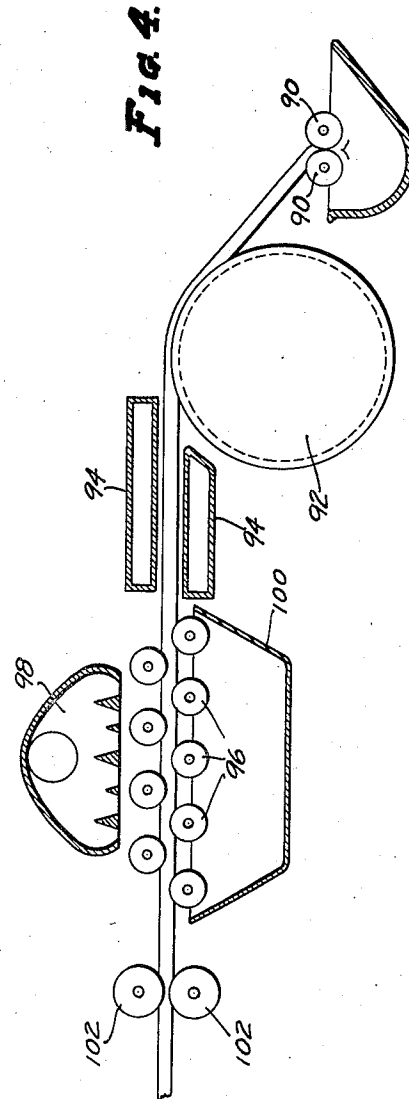
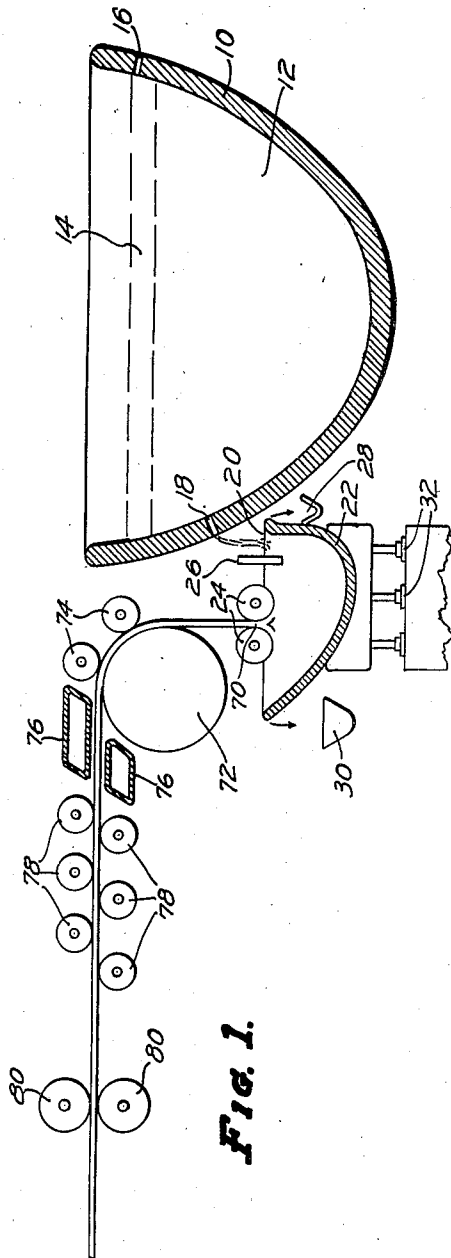
D. H. SWEET

2,069,485

METALLURGY

Filed Sept. 17, 1932

2 Sheets-Sheet 1



INVENTOR.
DONALD H. SWEET
BY *Freeman and Sweet*
ATTORNEYS

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FIG. 2.

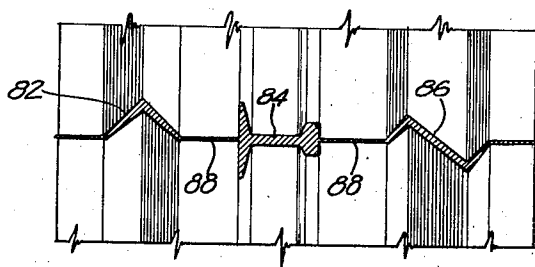
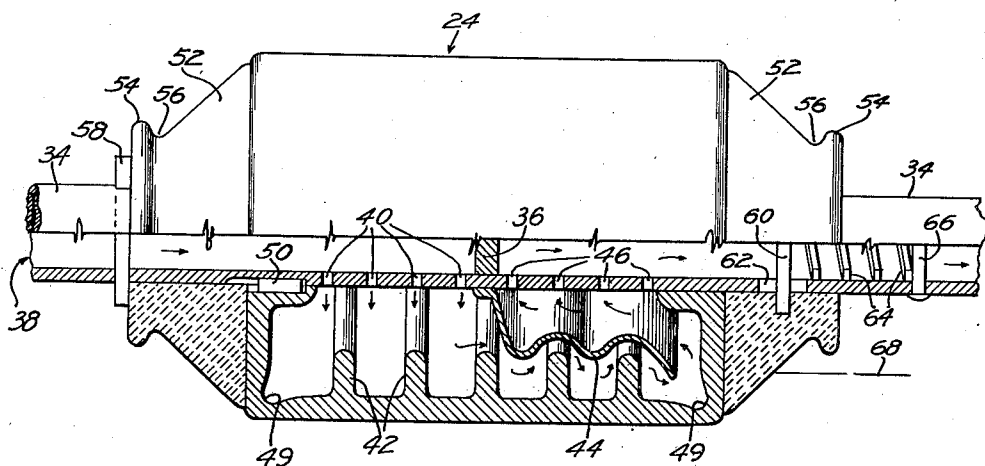


FIG. 3.

INVENTOR.

DONALD H. SWEET

BY

Freeman and Sweet

ATTORNEYS

UNITED STATES PATENT OFFICE

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METALLURGY

Donald H. Sweet, Evanston, Ill., assignor to
Hazelett Metals, Inc., New York, N. Y., a cor-
poration of Delaware

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14 Claims. (Cl. 29—33)

My invention relates to metallurgy, and includes among its objects and advantages the formation of finished steel shapes from molten metal in a continuous process.

5 In the accompanying drawings:

Figure 1 is a diagram of apparatus for carrying out the process;

Figure 2 is an enlarged view of one of the forming rolls, with the lower half in section;

10 Figure 3 is a diagram as in plan view looking into the crotch between a pair of forming rolls for forming special shapes; and

Figure 4 is a partial diagram of the apparatus for processing such shapes as shown in Figure 3.

15 In the embodiment of apparatus selected for illustration in Figure 1, 10 is a reservoir containing molten steel 12 and a slag blanket 14. To make the process continuous, additions of finished Bessemer or open hearth steel may be made at frequent intervals so as to cause continuous overflow of slag from the slag notch 16, and a continuous discharge of steel from the tap 18. The steel issuing from the tap 18 falls into the side pocket 20 of the adjustable bath 22, which pocket is separated from the forming rolls 24 by a refractory baffle 26 extending both above and below the level of the bath. The rate of discharge through the tap is regulated so that there is a small continuous overflow at 28 to remove substantially all traces of slag, and a small continuous overflow at 30 so that the level of the bath will be substantially constant and unaffected by variations in the rate at which the rolls 24 withdraw the material. The bath is supported on power driven jacks 32 so that it may be lowered to withdraw the bath from contact with the rolls 24 when the mill is to be stopped, and raised again to start operations.

Referring now to Figure 2, I have illustrated 40 one of the rolls 24 as comprising a hollow metal body mounted on a hollow shaft 34 with a central plug 36. Water is pumped in at the left end 38 and passes out through the holes 40, over the fins 42 in the interior of the roll, around the baffle 44 and out through the openings 46 and the other end of the shaft 34, in the form of steam. To protect the corners of the roll against fusion, the metal at 48 is made of slightly less thickness.

The roll is keyed to the shaft at 50, and mounted between refractory heads, each comprising a cone 52 with a small end enlargement 54 defining a groove 56. An abutment is provided at one end at 58, and the remote end cap 52 has a cross pin 60 passing through slots 62 in the shaft. A compression coil spring 64 between the pin 60

and an abutment pin 66 keeps the parts in axial contact. In use the rolls are immersed in the molten metal to the level indicated by the dotted line 68 in Figure 2, and rotated at such a speed that the cooling action will pick up a layer of molten metal on each roll of an axial thickness a trifle in excess of half the clearance between the rolls, so that the metal rising between the rolls at 70 in Figure 1 will be mechanically compressed. The strip now passes over a large chill roll 72 under the idlers 74, and between water-cooled boxes 76 constituting a radiation cooler. It then passes through leveling rolls 78 and a final pair of gauge rolls 80.

In Figure 3 I have indicated surface configuration for a pair of rolls shaped to deliver special structural shapes comprising angle 82, rail section 84, and a Z-bar 86. These shapes leave the forming rolls united to each other by thin webs at 88, which are cut off by shears to leave the finished article. In forming such shapes I proceed according to Figure 4, bending the shape about 60° about the left forming roll 90, and then around a large roll 92 which operates at a relatively high temperature so as not to chill the shape to a point where the bending of it will become difficult. As soon as the shape is straightened out, I pass it between the boxes 94 of a radiation cooler, and then between leveling rolls 96 deluged with water from a fountain 98. The tank 100 receives the excess water. The final gauge rolls 102 impart accuracy to the section of the finished shape.

I prefer to operate the forming rolls 24 and 90 at such speeds that the radial acceleration of their surfaces is equal to or slightly greater than gravity. Thus a roll of three feet maximum diameter delivering a strip of material at eight feet per second will have its periphery traveling with such radial acceleration that droplets of molten metal along the edges of the roll will not run down the conical portions 52, but will travel over the top and return to the bath. However, when it becomes necessary to operate at slower speeds, the trough 56 prevents molten metal from accumulating on the central shaft.

An advantageous heat treatment of the material may be accomplished simultaneously with its formation. Thus in forming strips according to Figure 1, I chill one face of the material against the roll 72 to a diameter below the critical point of the steel, and control the drawing of the chilled surface by the conduction of heat from the center of the strip by means of the radiation cooler 76.

In Figure 4 the cooling action of the forming rolls is made less to facilitate the bending of the shape, and the steel may leave the forming rolls at 2400° F. and travel in about three seconds to the large roll 92 with a temperature drop of 50° to 2350° F. It will remain in contact with the roll 92 for about one and one half seconds, and leave that roll at a temperature of 2000° F. The radiation cooler is of such length as to reduce the temperature to just about the critical point, say 1500° F., and the fountain 98 will quench it.

Without further elaboration the foregoing will so fully explain my invention that others may, by applying knowledge current at the time of such application, readily adapt the same for use under various conditions of service.

I claim:

1. The formation of a steel shape from molten metal by picking up a film or layer of metal on a relatively cold surface moving through a molten bath, stripping the congealed film from the cold surface, cooling the moving shape by a first cooling instrumentality to a predetermined temperature above the critical point, chilling or quenching the shape to a predetermined temperature well below the critical point by a second cooling instrumentality, and controlling the draw of the cooler portions of said shape by a third cooling instrumentality.

2. The formation of a steel shape from molten metal by picking up a film or layer of metal on a relatively cold surface moving through a molten bath, stripping the congealed film from the cold surface, cooling the moving shape by a first cooling instrumentality to a predetermined temperature above the critical point, and chilling or quenching the shape to a predetermined temperature well below the critical point by a second cooling instrumentality.

3. In a combination, a relatively large reservoir for containing molten metal, a tap for discharging metal from the reservoir at an approximately constant rate, a receptacle receiving the stream from said tap, baffle means subdividing the surface of the bath proper formed in said receptacle into a receiving area and a delivery area, overflow means for both areas, and forming rolls partially immersed in the delivery area and withdrawing metal therefrom.

4. In combination, a relatively large reservoir for containing molten metal, a tap for discharging metal from the reservoir at an approximately constant rate, a receptacle receiving the stream from said tap, baffle means subdividing the surface of the bath proper formed in said receptacle into a receiving area and a delivery area, overflow means for both areas, forming rolls partially immersed in the delivery area and withdrawing metal therefrom, and means for varying the relative elevations of said rolls and said receptacle.

5. In combination, a relatively large reservoir for containing molten metal, a tap for discharging metal from the reservoir at an approximately constant rate, a receptacle receiving the stream from said tap, baffle means subdividing the surface of the bath proper formed in said receptacle into a receiving area and a delivery area, overflow means for both areas, forming rolls partially immersed in the delivery area and withdrawing metal therefrom, said tap discharging material at a rate sufficiently in excess of the withdrawal by said rolls to maintain a molten discharge from both overflow means, and means for varying the relative elevations of said rolls and said receptacle.

6. The formation of a steel shape from a bath of molten metal which comprises causing a portion of the molten metal to move out of the bath in an upward direction between relatively cold forming surfaces to mold it into a finished shape of predetermined cross section and crystal structure.

7. The formation of a steel shape from molten metal by picking up two films or layers of molten metal on two relatively cold rolls dipped into a molten bath, pressing the metal films together as they pass the bight between the rolls, and controlling the cooling and formation of the metal films so that the combined thickness of the solidified metal films approaching the bight is materially greater than the width of the bight whereby the metal is subjected to work and the crystal structure of the metal is changed.

8. The formation of a metal shape from molten metal by picking up and freezing a plurality of films or layers of molten metal on a plurality of relatively cold surfaces of revolution moving through a molten bath, uniting the metal films into a single metallic strip having a crystal structure, further cooling said strip to change said crystal structure, and forming it into a shape of predetermined cross section.

9. The formation of a metal shape from molten metal by picking up and freezing two films or layers of molten metal on two relatively cold surfaces dipped into a bath of said molten metal, compressing the rising metal films between said rolls to unite said films together and to change the crystal structure, further cooling said compressed films to further change the crystal structure, and forming the same into a shape of predetermined cross section.

10. The formation of a metal shape from molten metal by picking up and freezing two films or layers of molten metal on two relatively cold rolls dipped into a bath of said molten metal, uniting the rising metal films between said rolls, stripping the same from the said rolls, further cooling the same to change the crystal structure thereof and forming the same into a shape of predetermined cross section.

11. The formation of a solid metal shape of substantially cross section throughout its length directly from molten metal which comprises picking up and freezing a plurality of metal films or layers of molten metal on a plurality of relatively cold surfaces of revolution moving through a bath of said molten metal, uniting the said metal films into a single strip having a crystal structure and having a substantially constant cross section throughout its length, stripping the said strip from said cold surfaces, further cooling the same to change the crystal structure thereof, and forming the same into a shape having a substantially constant cross section throughout its length.

12. In combination, a relatively large reservoir for containing molten metal, a tap for discharging metal from the reservoir at an approximately constant rate, a receptacle receiving the stream from said tap, baffle means subdividing the surface of the bath proper formed in said receptacle into a receiving area and a delivery area, and relatively cold forming rolls partially immersed in the delivery area for withdrawing metal therefrom and freezing the same.

13. The formation of a metal shape from molten metal by picking up a film or layer of metal on a relatively cold surface moving through a molten bath, stripping the congealed film from the cold surface, cooling the moving shape by a

first cooling instrumentality to a predetermined temperature above a critical point, chilling or quenching the shape to a predetermined temperature well below said critical point by a second cooling instrumentality, and controlling the draw of the cooler portions of said shape by a third cooling instrumentality.

14. The formation of a metal shape from molten metal by picking up a film or layer of

metal on a relatively cold surface moving through a molten bath, stripping the congealed film from the cold surface, cooling the moving shape by a first cooling instrumentality to a predetermined temperature above a critical point, and chilling or quenching the shape to a predetermined temperature well below said critical point by a second cooling instrumentality.

DONALD H. SWEET.