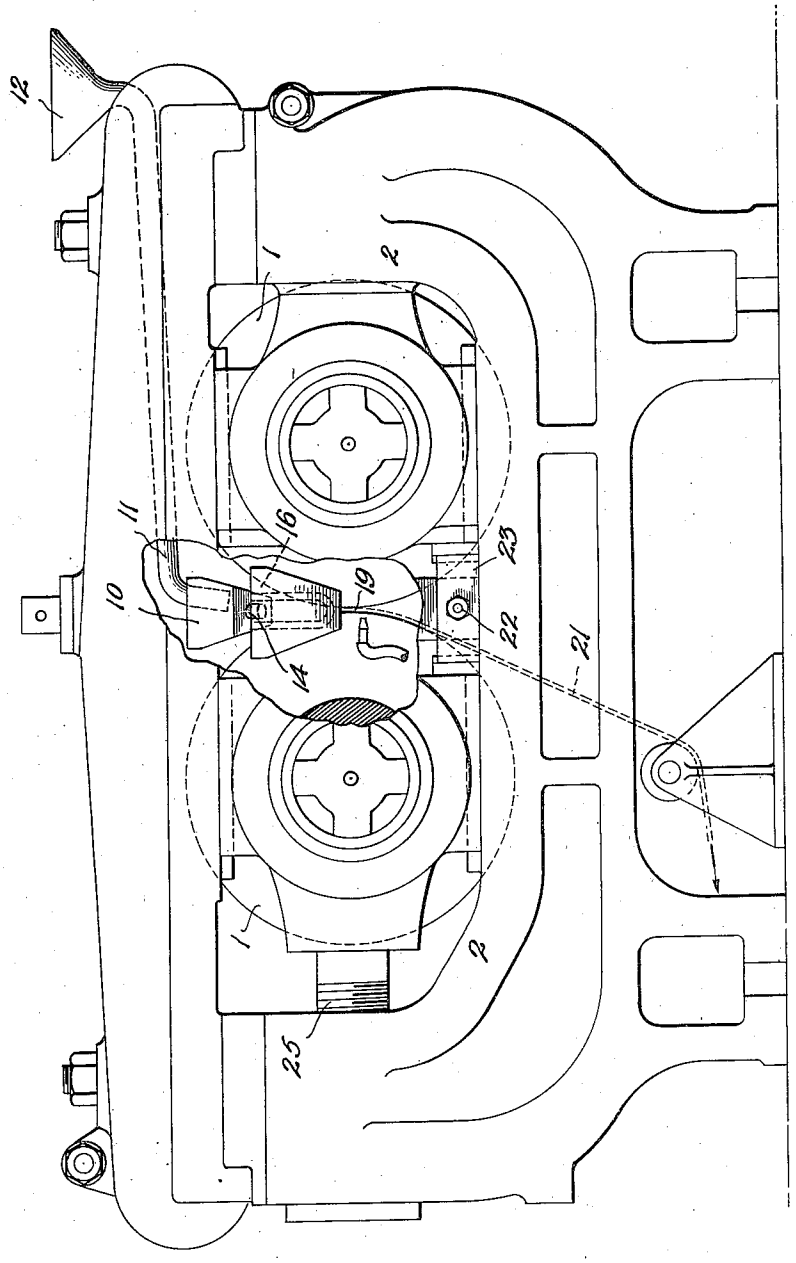
Aug. 23, 1938. C. W. HAZELETT 2,127,515

METHOD OF PRODUCING SOLID METAL OF SUBSTANTIALLY CONSTANT CROSS SECTION THROUGHOUT ITS LENGTH DIRECTLY FROM A MASS OF MOLTEN METAL AND TO AN APPARATUS THEREFOR

Filed June 7, 1937 5 Sheets-Sheet 1

Fig. 1.



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Filed June 7, 1937 5 Sheets-Sheet 2

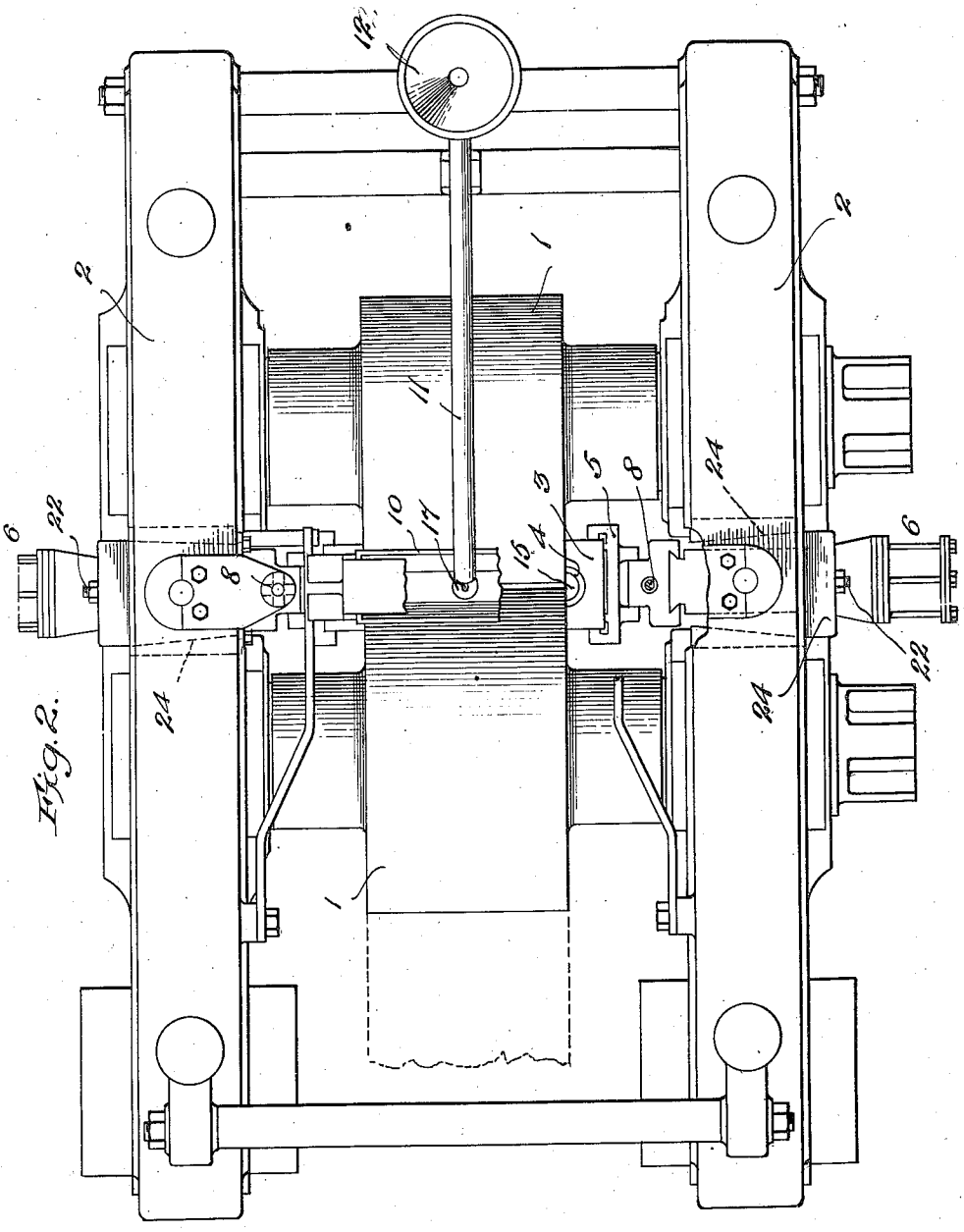


Fig. 2.

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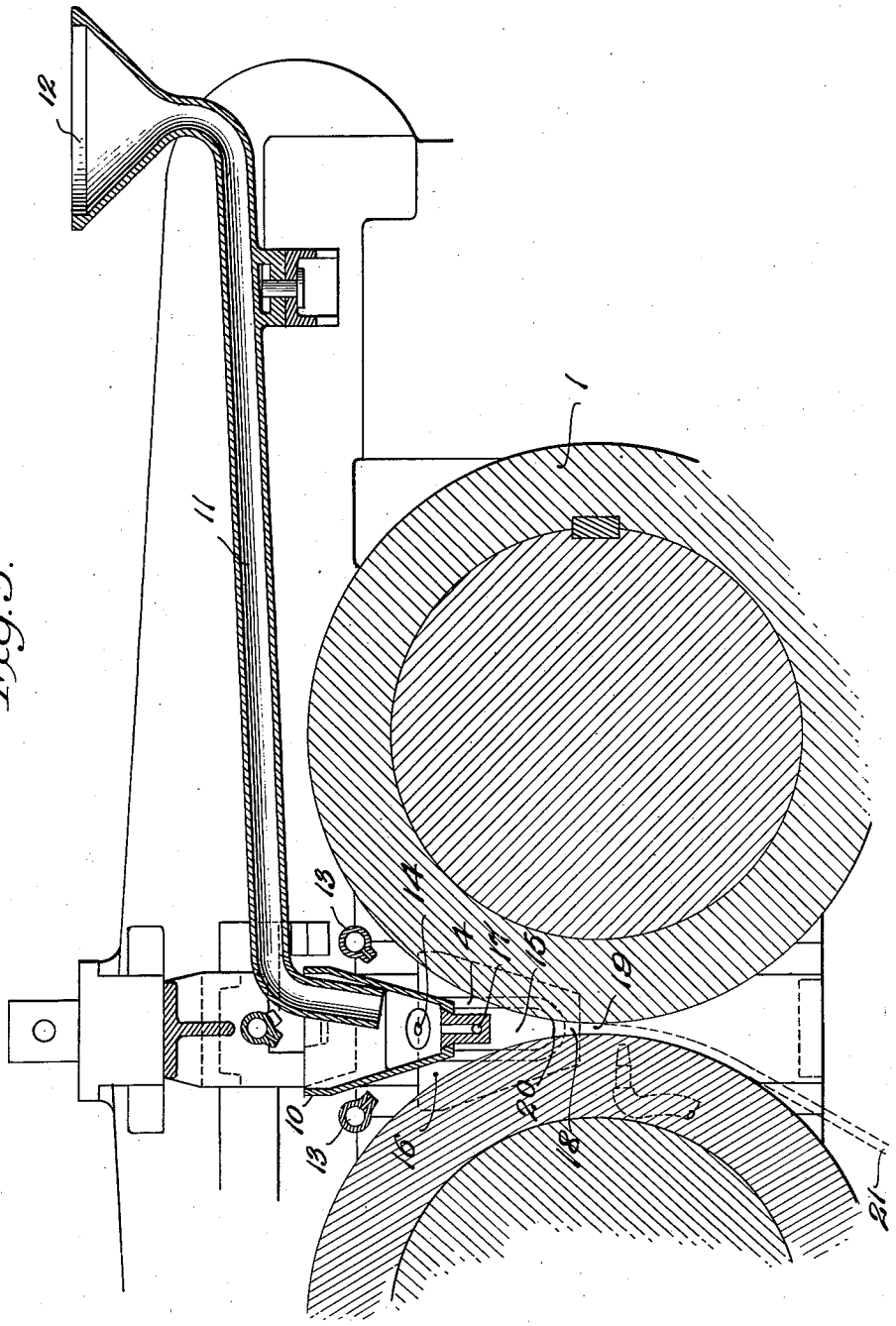
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Filed June 7, 1937 5 Sheets-Sheet 3

Fig. 3.



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Filed June 7, 1937 5 Sheets-Sheet 4

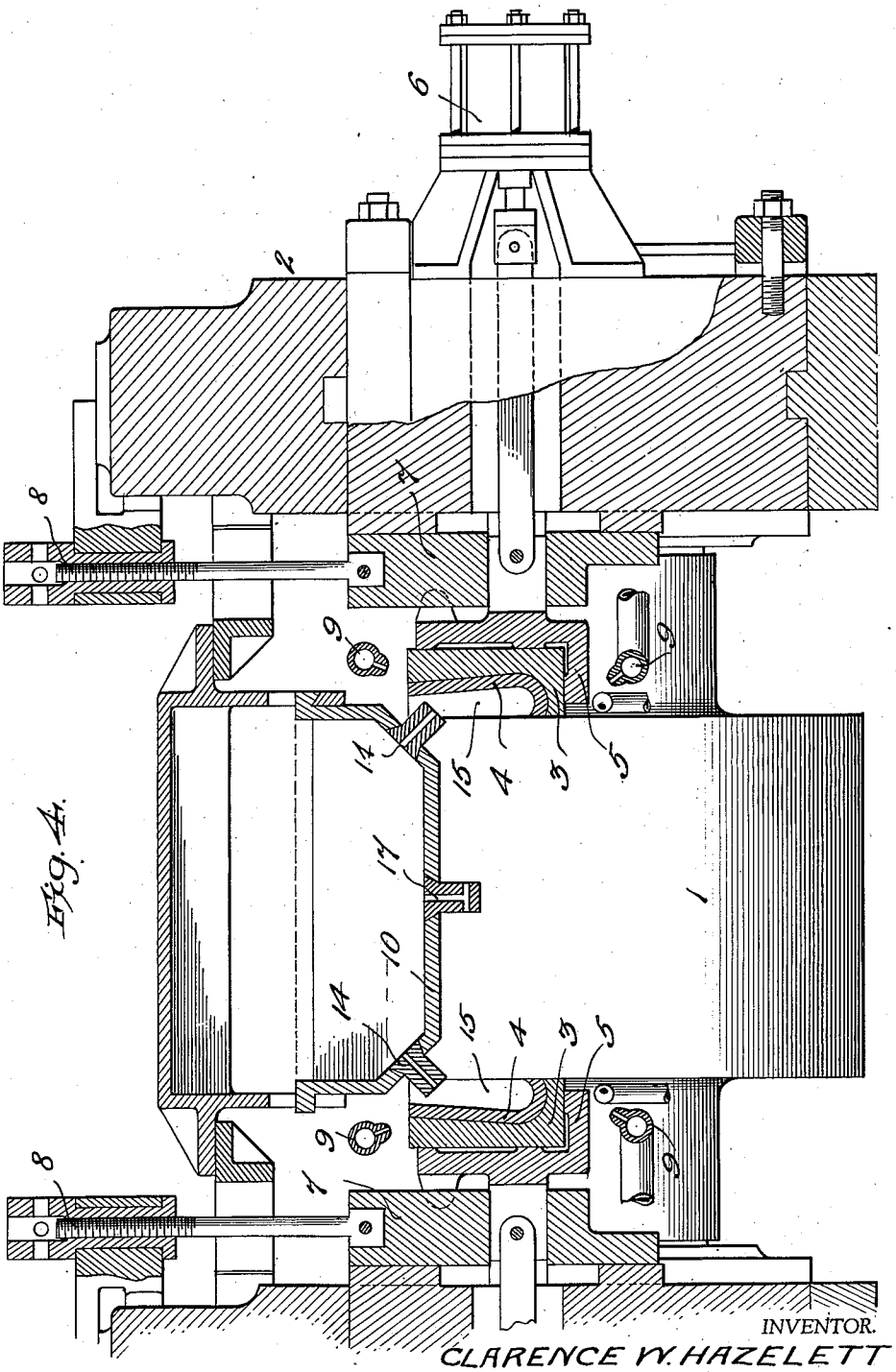


Fig. 4.

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Filed June 7, 1937 5 Sheets-Sheet 5

Fig. 5.

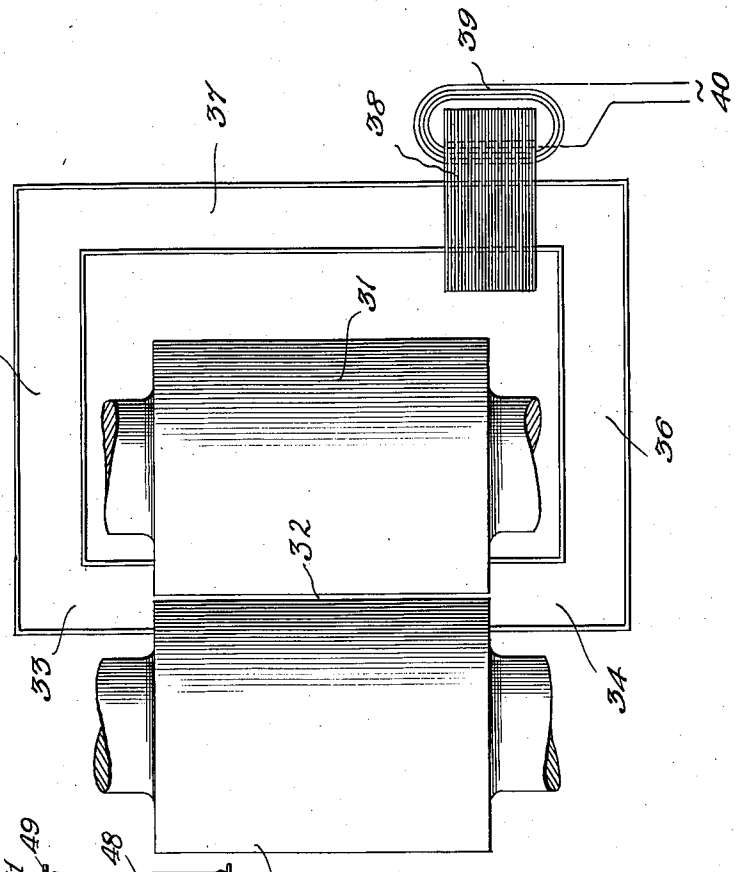
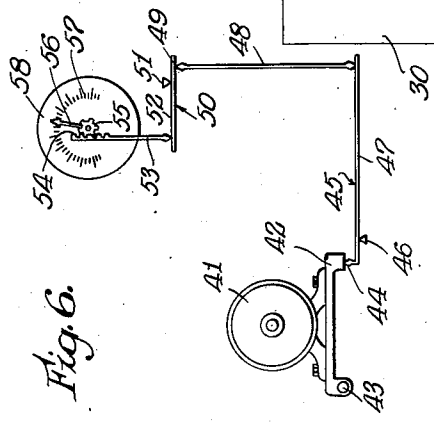


Fig. 6.



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Patented Aug. 23, 1938 2,127,515

UNITED STATES PATENT OFFICE

2,127,515

METHOD OF PRODUCING SOLID METAL OF SUBSTANTIALLY CONSTANT CROSS SECTION THROUGHOUT ITS LENGTH DIRECTLY FROM A MASS OF MOLTEN METAL AND TO AN APPARATUS THEREFOR

Clarence W. Hazelett, Greenwich, Conn.

Application June 7, 1937, Serial No. 146,792

35 Claims. (Cl. 22—200.1)

The present invention relates to methods and apparatus for producing metal products directly from molten state, and, more particularly, to new and improved methods and apparatus of the character described.

I have discovered an improved method of compensating for the increased cooling caused by the end dams of rolls and an improved method of producing strip, sheet and other solid products directly from molten metal.

It is an object of the present invention to provide an improved process and apparatus for producing metal products directly from molten metal which is satisfactory and is capable of producing commercial products on an industrial scale.

It is another object of the present invention to provide a novel and improved apparatus for producing metal products directly from molten metal in which an end dam of such character is provided that substantially no cooling effect is exerted in the marginal or end portions of the molten metal bath or pool.

It is a further object of the invention to provide an improved end dam for a mill producing metal products directly from molten metal, said end dam being constituted of molten metal and having substantially the same temperature as the metal bath above the bight of the rolls.

The invention also contemplates an improved mill for producing metal products directly from molten metal embodying a molten metal end dam which is simple in construction and which may be readily and satisfactorily operated on an industrial scale without requiring critical adjustment of the thermal conditions and without complex and expensive control equipment.

Other and further objects and advantages of the present invention will become apparent from the following description taken in conjunction with the accompanying drawings, in which

Fig. 1 illustrates the general view of a mill embodying the principles of the present invention;

Fig. 2 depicts a vertical sectional view across the rolls shown in Fig. 1;

Fig. 3 is a longitudinal sectional view of the mill;

Fig. 4 is a top plan view of the mill;

Fig. 5 illustrates a diagrammatic view somewhat fragmentary, of a modified embodiment of the present invention; and

Fig. 6 depicts a conventional torque indicator employed in connection with the mill embodying the invention.

Broadly stated, according to the principles of my invention I provide an end dam constituted of molten metal. I prefer to provide this molten metal dam as a part of the bath or pool of molten metal employed for the production of the metal article. This can be accomplished for example by providing a member having a pocket-shaped cavity therein pressed against the side surface of the rolls in the place of the conventional dam structure. This pocket-shaped cavity is preferably provided with a refractory lining and is preheated by means of a gas flame or some other heating means. I preferably fill this pocket-shaped cavity with a molten metal of the same character and temperature as the one employed for the production of the metal strip from the same source as the main metal bath or pool above the bight of the rolls. In this manner a dam constituted of molten metal is obtained having substantially the same temperature as the main bath or pool so that cooling of the terminal portions of the bath adjacent to the edges of the rolls is practically completely eliminated.

I have found that the dam member having the pocket-shaped cavity has to be adjustable both in horizontal and in vertical direction in order to obtain the best results. Thus, an air cylinder may be provided for pressing the pocket-shaped member against the side surface of the rolls with yielding pressure and an additional vertical screw adjustment may be provided to permit raising and lowering the pocket and thereby the molten end dam with respect to the rolls. I have made the surprising discovery that best results are obtained when the bottom of the pocket is raised above the point of maximum approach of the rolls so as to leave an open space immediately above the bight of the rolls. The molten metal poured into the pocket from the source of molten metal or from a distributing box will flow into the space between the rolls without any appreciable vertical movement thus preventing the disturbance of the metal already frozen in the mill by the incoming stream. This desirable condition may be further supplemented and assisted by introducing the metal into the pocket shaped end dam above the bight of the rolls underneath the surface of the bath and in a substantially horizontal direction by means of a nozzle having horizontal outlet openings. In this manner the molten metal mass contained in the pocket-like cavity represents a dam constituted of molten metal having substantially the same character and temperature as the main bath or pool of metal which in fact forms an extension of the

main bath or pool beyond the edges of the rolls. This molten metal dam has the considerable advantage that it has the same temperature as the main bath of molten metal and therefore does not cause any appreciable cooling of the main bath or pool at the terminal portions thereof. I prefer to so adjust the molten end dam that its bottom is slightly above the point of maximum approach of the rolls. This will permit the solidified metal to extrude laterally to a small extent producing a slightly roughened edge on the product which may be trimmed off without any difficulty. Preferably, the thermal conditions are so controlled that the temperature of the solidified metal at the bight of the rolls is substantially the same in the zones adjacent to the dams and the intermediate zones of the molten bath. This can be accomplished, for example, by feeding more molten metal to the zones adjacent to the dams than to the intermediate zones, and by varying said additions of molten metal with changes indicated by a torque indicator operatively associated with the rolls.

I have also discovered that the distance between the rolls, which substantially determines the gauge of the product can be adjusted with great accuracy by means of wedges slideably inserted between the bearings to keep them apart. The mill is preloaded by putting some pressure on the screws provided for this purpose, the wedges between the bearings permitting to set them accurately. This greatly improves the accuracy of the gauge of the product, and permits to maintain the gauge between very close limits.

The invention will now be described more fully to those skilled in the art, reference being had to the accompanying drawings illustrating by way of example a preferred embodiment of my invention in the form of a mill producing solid strip-like metal articles directly from molten metal.

Referring to Figs. 1 to 4, a horizontal rolling mill is illustrated comprising a pair of rolls 1 rotatably mounted in supports 2 in conventional manner. At both ends of the rolls a dam supporting member 3 is provided having a pocket-shaped refractory lining 4 adapted to receive and to hold a body of molten metal which is to act as an end dam. Support 3 is movably mounted in a cradle 5 and is pressed against the end surface of the rolls by means of an air cylinder 6. The entire unit is adjustable in the vertical direction by means of a slide member 7 and a screw 8. The complete end dam structure is preheated and is maintained at a preferred high temperature by means of a flame emerging from a gas pipe 9.

Above the bight of the rolls 1, a distributing box 10, is provided which provides an auxiliary source or reservoir of the molten metal prior to its introduction into the bight of the rolls and into the dam pockets. Distributing box 10 is supplied with molten metal through a pipe 11 and a funnel-like member 12 and is maintained at a high temperature by means of gas jets 13. At each end of the distributing box a nozzle 14 is provided through which the molten metal may flow out into the pockets 15 wherein it changes its direction and flows back into the space 16 between the rolls in a substantially horizontal direction and forms a main body or pool of molten metal therein. Likewise, a nozzle 17 provided in the central portion of distributing box 10 discharges part of the molten metal towards the center of the mill in a substantially horizontal direction, as it will be more fully described hereinafter.

From the preceding description the operation of my improved apparatus and of my molten metal end dam will be readily understood by those skilled in the art. Distributing box 10 is continuously supplied with molten metal of preferred character and temperature from a conventional source. From distributing box 10, a metal will flow through nozzles 14 and 17 into the pockets 15 and into the space between the rolls, it will be readily observed from the drawings that the molten metal poured into pockets 15 will flow into the space between the rolls without any appreciable vertical movement thereby preventing any detrimental disturbance of the metal already frozen in the mill by the incoming hot stream. Of course, the same applies to metal entering directly into the space between the rolls from the distributing box 10 through the nozzle 17, in view of the horizontal arrangement of the outlet openings in nozzle 12. The molten metal mass contained in pockets 15 represents a molten metal end dam which is directly contiguous with the bath or pool in the space between the rolls. The height of this molten metal dam may be adjusted by means of screw 8 and is preferably raised above the point of maximum approach of the rolls so as to leave an open space at point 18.

In the case low melting point metals are employed, the refractory lining 4 may be omitted since the metal stream from nozzles 14 heats the end dam proper 3 to a sufficiently high temperature to prevent freezing of any excess metal between the limits of the ends of the rolls. In other words, the molten metal bath is extended beyond the ends of the rolls and forms liquid end dams having substantially the same temperature as the main body of metal above the bight of the rolls.

I have found that it is very desirable to provide for yielding displacement of the members 4, 3 and 5 and of the molten end dam contained therein under pressure. This yielding and resilient displacement is made possible by the provision of the air cylinder 6 which permits displacement of cradle 5 in the horizontal direction and is adapted to compensate for displacements of the rolls in the horizontal direction, as are, for example, caused by heat expansion. I have also found that excessive pressures may be built up close to the point of maximum approach of the rolls, this point being designated by reference character 19. This is particularly the case when extremely refractory metals are worked. To avoid these excessive pressures, the stationary end dam is vertically adjusted by means of screw 8 so that its bottom is slightly above the point of maximum approach of the rolls whereby metal is permitted to extrude laterally to a slight extent. This will cause production of a slightly rough edge on the strip which may be trimmed off without difficulty during the further progress of the process. The height of the dam is so adjusted that the metal is either plastic or is entirely solidified before it reaches the bottom of the dam designated by reference character 20. I designate this type of dam construction as an "open crotch" end dam. This type of construction is particularly important in the production of a strictly cast strip of metal which may be subsequently rolled. If, due to excessive solidification, any pressure builds up at the end of the roll, this will force the yieldably mounted rolls

apart and will permit the metal to run through in a molten condition in the center of the mill.

The distance between the rolls can be adjusted with great accuracy by means of wedges **23** slideably inserted between the terminal surfaces **24** of the bearings to keep them apart. The mill is preloaded by putting some pressure on screws **25** provided for this purpose, after wedges **23** have been adjusted by means of screws **22**. This permits to set the rolls with great accuracy and to maintain the gauge within very close limits.

Fig. 5 illustrates a diagrammatic view of a modified embodiment of the present invention. Essentially, a pair of rolls, **30** and **31**, are provided in juxtaposed and cooperating relation. A main bath **32** is located above the bight of the rolls and auxiliary baths **33** and **34** forming molten end dams are maintained at the ends of the rolls. Thin pouring channels **35** and **36** are provided beyond the ends of the rolls and below the tops of the rolls for feeding molten metal to the end dams and to the main bath from main inlet channel **37** which is connected to the ends of the pouring channels and is supplied with molten metal from a suitable source (not shown). As it will be readily observed from the drawings, main bath **32**, auxiliary baths **33** and **34**, pouring channels **35** and **36** and main inlet channel **37** form a completely closed electrical circuit having substantially the same surface level. A laminated iron core **38** is provided around the main inlet channel and has a coil **39** associated therewith. Coil **39**, which is connected to a source of alternating current **40** permits to induce powerful alternating currents in this closed electrical circuit and makes possible to heat said circuit and the metal therein to a preferred temperature. Preferably, pouring channels **35** and **36** have a smaller cross section than main inlet channel **37**, in order to provide a greater heating effect therein.

The advantage of this modified embodiment is that substantially the same surface level is positively maintained in the complete circuit of molten metal. All of the molten metal enters the main bath in an entirely horizontal direction and from the ends thereof and the possibility of detrimental vertical streams between the roll ends is completely prevented. Moreover, the induction heating as employed in this modified embodiment of the invention provides simple and extremely accurate control of the temperature of the bath at all of its points.

As those skilled in the art know, in a mill of the character described, the torque required to drive the mill follows the ratio between the extent of solidification and the spacing of the rolls. Therefore, I found it particularly advantageous to provide means to indicate continuously the torque required to drive the mill. This torque indicator means may be of conventional form, such as, for example, is disclosed in my U. S. Patent No. 2,058,447. An indicator of this form is shown in Fig. 6 and essentially comprises a mill motor **41** mounted on a base **42** pivoted at one end at **43** and resting at the other end on the knife edge **44**. Knife edge **44** is carried on the short arm of a lever **45** pivoted at **46** and having its long arm **47** connected by a link **48** to the short arm **49** of a lever **50**. This lever in turn is pivoted at **51** and has its long arm **52** engaging a reciprocating bar **53**. One side of bar **53** carries a rack **54** which engages a pinion **55** to which is secured an indicator arm **56** co-operating with scale **57** of an indicator **58**. Depression of the free end of the base **42** is opposed continually in constantly increasing amount, by any biasing means suitable for the purpose, as in a scale. In view of the conventional character of this arrangement, its operation will be readily understood without any further explanation.

I have found that the importance of compensating for the excess cooling due to the end dams or the flanges of the rolls acting as end dams becomes greater as more refractory metals are employed. I have found that particularly in the case of mills less than 12" in width, difficulty is experienced in producing a satisfactory strip because of the high percentage of cooling due to the above factors. In a mill 8" in width for use with brass, unless some other form of compensation is used, it was heretofore necessary to pour practically all of the brass close to the ends of the rolls in order to avoid excessive solidification at this point with consequent damage to the mill by upsetting the edges of the rolls. Excessive cooling and solidification of the metal at the ends of the rolls would cause folding of the metal which freezes on the flange or end dam and produced a strip which was unsound for some distance from the edges. In some cases the pressure was sufficient to force the flanges off the rolls or to otherwise damage the rolls. The molten metal end dam according to the principles of the present invention completely eliminates all of these difficulties and permits producing a satisfactory strip of any width even from highly refractory metals in a simple and efficient manner with practically no danger of damage or injury to the rolls or to the other elements of the mill.

In practical operation, I have found it very advantageous to pour all of the metal in the end dam, particularly in mills having a width of at least two feet. This assures that no molten metal will enter the bath appreciably above its operating surface. The yieldable end dam mounting becomes extremely important in such wide mills and particularly in casting mills in which it is yieldable to have hot rolls. The yielding mounting for the end dams readily compensates for the expansion of the rolls and prevents the occurrence of excessive stresses at the roll ends.

I claim:

1. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, restraining said bath against lateral extension at two surfaces beyond the ends of said rolls to provide two auxiliary baths contiguous with the end of said main bath, and rotating said rolls to cause the ejection of solidified metal from the bight of the rolls, said metal having a width substantially equal to that of said rolls and less than the combined lengths of said main and said auxiliary baths.

2. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a space above the bight of a pair of operatively associated rolls and between a pair of dam surfaces at a distance from the ends of said rolls, feeding molten metal to said space to maintain a main bath of molten metal and an auxiliary bath forming a molten end dam at each side of said main bath, and rotating said rolls to cause the ejection of solidified metal from the bight of the rolls, said metal having a width substantially equal to that of

said rolls and less than the combined length of said main and said auxiliary baths.

3. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a space above the bight of a pair of operatively associated rolls and between a pair of dam surfaces at a distance from the end of said rolls, feeding molten metal to said space to maintain a main bath of molten metal and an auxiliary bath forming a molten end dam at each side of said main bath, said molten end dams having substantially the same temperature and character as said main bath, and rotating said rolls to cause the ejection of solidified metal from the bight of the rolls, said metal having a width substantially equal to that of said rolls and less than the combined lengths of said main and said auxiliary baths.

4. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam constituted of molten metal at each end of the rolls to laterally restrain said main bath between the rolls and to establish a pair of auxiliary baths contiguous with the ends of said main bath, and rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

5. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam of molten metal at each end of the rolls to laterally restrain said bath and to establish a pair of auxiliary baths contiguous with the end of said main bath, said auxiliary baths being constituted of molten metal having substantially the same character and temperature as said main bath, maintaining said molten metal to a selected height in said main and auxiliary bath, and rotating said rolls to cause the ejection of solidified metal from the bight of the rolls, said metal having a width substantially equal to that of said rolls and less than the combined lengths of said main and said auxiliary baths.

6. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam constituted of molten metal at each end of the rolls to laterally restrain said bath and to establish a pair of auxiliary baths contiguous with the ends of said main bath, feeding molten metal to said baths to maintain a selected height therein, and rotating said rolls to cause the ejection of solidified metal from the bight of the rolls said metal having a width substantially equal to that of said rolls and less than the combined lengths of said main and said auxiliary baths.

7. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam constituted of molten metal at each end of the rolls to laterally restrain said main bath and to establish a pair of auxiliary baths contiguous with the ends of said main bath, continuously feeding molten metal to said main and said auxiliary baths without disturbing the metal already frozen in the bight of the rolls, and rotating said rolls to cause the ejection of solidified metal from the bight of the rolls, said metal having a width substantially equal to that of said rolls and less than the combined lengths of said main and said auxiliary baths.

8. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam constituted of molten metal at each end of the rolls to laterally restrain said main bath and to establish a pair of auxiliary baths contiguous with the ends of said main bath, continuously feeding molten metal to said baths underneath the surface thereof and in a substantially horizontal direction, and rotating said rolls to cause the ejection of solidified metal from the bight of the rolls said metal having a width substantially equal to that of said rolls and less than the combined length of said main and said auxiliary baths.

9. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam of molten metal at each end of the rolls to laterally restrain said main bath and to establish a pair of auxiliary baths contiguous with the ends of the said main bath, adjusting the position of said molten end dams so that their bottom is raised above the point of maximum approach of the rolls, continuously feeding molten metal to said main bath directly and through said auxiliary baths substantially underneath the surface thereof and in a substantially horizontal direction, and rotating said rolls to cause the ejection of solidified metal from the bight of the rolls, said metal having a width substantially equal to that of said rolls and less than the combined lengths of said main and said auxiliary baths.

10. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam constituted of molten metal at each end of the rolls to laterally restrain said main bath and to establish a pair of auxiliary baths contiguous with the ends of said main bath, rotating said rolls to cause the ejection of solidified metal from the bight of the rolls, said metal having a width substantially equal to that of said rolls and less than the combined lengths of said main and said auxiliary baths, and controlling the thermal conditions so that the temperature of the solidified metal at the bight of the rolls is substantially the same in the zones adjacent to the dams and the intermediate zones of the molten bath.

11. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam constituted of molten metal at each end of the rolls to laterally restrain said main bath and to establish a pair of auxiliary baths contiguous with the ends of

said main bath, rotating said rolls to cause the ejection of solidified metal from the bight of the rolls, said metal having a width substantially equal to that of said rolls and less than the combined lengths of said main and said auxiliary baths, maintaining said molten metal to a selected height in said bath, adding molten metal to said baths, and varying said additions of molten metal with changes indicated by a torque indicator operatively associated with the said rolls.

12. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam constituted of molten metal at each end of the rolls to laterally restrain said main bath and to establish a pair of auxiliary baths contiguous with the ends of said main bath, driving said rolls by means of a motor to cause the ejection of solidified metal from the bight of the rolls, said metal having a width substantially equal to that of said rolls and less than the combined lengths of said main and said auxiliary baths, and controlling the solidification by means of an indicator operatively associated with said motor.

13. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam at each end of the rolls to laterally restrain said bath, adjusting the position of said dams so that their bottom is raised above the point of maximum approach of the rolls, continuously feeding molten metal to said bath without disturbing the metal already frozen in the bight of the rolls, and rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

14. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam constituted of molten metal at each end of the rolls to laterally restrain said bath and to establish a pair of auxiliary baths contiguous with the ends of said main bath, feeding molten metal solely to said auxiliary baths to maintain a selected height in said main and auxiliary baths, and rotating said rolls to cause the ejection of solidified metal from the bight of the rolls, said metal having a width substantially equal to that of said rolls and less than the combined lengths of said main and said auxiliary baths.

15. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam constituted of molten metal at each end of the rolls to laterally restrain said bath and to establish a pair of auxiliary baths contiguous with the ends of said main bath, feeding molten metal solely to said auxiliary baths to maintain a selected height in said main and auxiliary baths, controlling the introduction of molten metal in such a manner that no molten metal will enter said baths appreciably above the operating surface thereof, and rotating said rolls to cause the ejection of solidified metal from the bight of the rolls, said metal having a width substantially equal to that of said rolls and less than the combined lengths of said main and said auxiliary baths.

16. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam constituted of molten metal at each end of the rolls to laterally restrain said bath and to establish a pair of auxiliary baths contiguous with the ends of said main baths, establishing a closed circuit of molten metal including said main and auxiliary baths, feeding molten metal to said circuit to maintain a selected height therein, and rotating said rolls to cause the ejection of solidified metal from the bight of the rolls, said metal having a width substantially equal to that of said rolls and less than the combined lengths of said main and said auxiliary baths.

17. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam constituted of molten metal at each end of the rolls to laterally restrain said bath and to establish a pair of auxiliary baths contiguous with the ends of said main bath, establishing a closed circuit of molten metal including said main and auxiliary baths, feeding molten metal to said circuit to maintain it at a constant height, maintaining the molten metal in said circuit at a preferred temperature by means of induction heating, and rotating said rolls to cause the ejection of solidified metal from the bight of the rolls, said metal having a width substantially equal to that of said rolls and less than the combined lengths of said main and said auxiliary baths.

18. The method of producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal which comprises establishing a main bath of molten metal between a pair of adjacent and operatively associated rolls, providing a dam constituted of molten metal at each end of the rolls to laterally restrain said bath and to establish a pair of auxiliary baths contiguous with the ends of said main bath, establishing a closed circuit of molten metal including said main and auxiliary baths, feeding molten metal to said circuit to maintain it at a constant height, maintaining the molten metal in said circuit at a preferred temperature by means of induction heating, restricting the cross section of said circuit at the points where increased heating effect is desired, and rotating said rolls to cause the ejection of soidified metal from the bight thereof.

19. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprising a pair of rolls, means for rotatably supporting said rolls in an adjacent and operatively associated relation, means for feeding molten metal into the bight of said rolls to establish a bath of molten metal therein, an end dam at each end of said rolls and constituted of a molten metal to laterally restrain said bath of molten metal, and means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

20. A rolling mill for producing solid metal of substantially constant cross section throughout

its length directly from a mass of molten metal comprising a pair of rolls rotatably mounted in an adjacent and cooperating position, means for feeding molten metal into the bight of said rolls to establish a main bath of molten metal therein, a dam supporting member at each end of said rolls, a bath of molten metal supported by each of said members and forming a molten end dam for said main bath, and means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

21. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprising a pair of rolls rotatably mounted in an adjacent and cooperating position, a dam supporting member having a pocket shaped cavity at each end of said rolls, means for feeding molten metal into the bight of said rolls to establish a main bath of molten metal therein, means for feeding a molten metal having a character and temperature similar to that of said main bath into said cavities to form a molten end dam therein to laterally restrain said main bath of molten metal, and means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

22. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprising a pair of rolls rotatably mounted in an adjacent and cooperating position, a dam supporting member having a pocket shaped cavity at each end of said rolls, means for feeding a molten metal into the bight of the rolls and in between said cavities to establish a bath of molten metal therein extending beyond the end of said rolls, the terminal portions of said bath extending beyond the end of said rolls forming molten end dams restraining the center portion of said bath, and means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

23. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprising a pair of rolls rotatably mounted in an adjacent and cooperating position, a dam supporting member having a pocket shaped cavity at each end of said rolls, means for feeding a molten metal into the space defined by the bight of said rolls and said cavities to establish a bath of molten metal therein, the terminal portions of said bath extending beyond the ends of said rolls forming a molten end dam for laterally restraining the central portion of said bath, means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls, and means for adjusting said dam supporting members for controlling said molten end dam.

24. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprising a pair of rolls rotatably mounted in an adjacent and cooperating position, a dam supporting member having a pocket shaped cavity at each end of said rolls, means for feeding a molten metal into the space defined by the bight of the rolls and said cavities to establish a bath of molten metal therein, the terminal portions of said bath extending beyond the end of said rolls forming molten end dams for laterally restraining the central portion of said bath, means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls, and means for displacing said dam supporting members in the horizontal and in the vertical direction to adjust said molten end dam.

25. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprising a pair of rolls rotatably mounted in an adjacent and cooperating position, a dam supporting member at each end of said rolls, a pocket shaped refractory lining in each of said members, means for yieldingly pressing said members against the end surface of the rolls, means for adjusting said members in the vertical direction, means for feeding a molten metal into the space defined by the bight of said rolls and said pocket shaped lining to establish a bath of molten metal therein, the terminal portions of said bath extending beyond the ends of said rolls forming a molten end dam for laterally restraining the central portion of said bath, and means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

26. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprises a pair of rolls rotatably mounted in an adjacent and cooperating position, a dam supporting member at each end of said rolls, a pocket shaped refractory lining in each of said members, means for preheating said members and said lining, an air cylinder for yieldingly pressing said members against the end surface of the rolls, a vertically displaceable slide member for adjusting said supporting members in the vertical direction, means for feeding a molten metal into the space defined by the bight of said rolls and said pocket shaped lining to establish a bath of molten metal therein, the terminal portions of said bath extending beyond the end of said rolls forming a molten end dam for laterally restraining the central portion of said bath, and means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

27. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprising a pair of rolls rotatably mounted in an adjacent and cooperating position, a dam supporting member having a pocket shaped cavity at each end of said rolls, means for yieldingly pressing said members against the end surface of the rolls, means for adjusting said members in the vertical direction, a distributing box located above the bight of the rolls, means for feeding molten metal to said distributing box, means for discharging molten metal from said box into the space defined by the bight of said rolls, and said cavities to establish a bath of molten metal therein, the terminal portions of said bath extending beyond the ends of said rolls and forming molten end dams, and means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

28. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprising a pair of rolls rotatably mounted in an adjacent and cooperating position, a dam supporting member having a pocket shaped cavity at each end of said rolls, means for yieldingly pressing said members against the end surfaces of the rolls, means for adjusting said members in the vertical direction, a distributing box located above the bight of the rolls, means for feeding molten metal to said distributing box,

a plurality of nozzles in said distributing box for discharging metal from said box into the space defined by the bight of said rolls and said cavities to establish a bath of molten metal therein, the terminal portions of said bath extending beyond the ends of said rolls and forming molten end dams, and means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

29. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprising a pair of rolls rotatably mounted in an adjacent and cooperating position, an end dam at each end of said rolls, means for yieldingly pressing said dams against the end surface of the rolls, means for adjusting said dams in the vertical direction, means for feeding a molten metal into the space defined by the bight of said rolls and said dams to establish a bath of molten metal therein, and means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

30. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprising a pair of rolls rotatably mounted in an adjacent and cooperating position, an end dam at each end of said rolls, a supporting member for each of said dams, an air cylinder for yieldingly pressing said members and said dams against the end surface of the rolls, a vertically displaceable slide member for adjusting said supporting members in the vertical direction, means for feeding a molten metal into the space defined by the bight of said rolls and said dams to establish a bath of molten metal therein, and means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

31. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprising a pair of rolls, means for rotatably supporting said rolls in an adjacent and operatively associated relation, a main bath of molten metal located above the bight of said rolls, an auxiliary bath of molten metal at each end of said rolls and contiguous with said main bath to restrain the same, means for feeding molten metal to said auxiliary baths to maintain the metal in said main and auxiliary baths at a preferred height, and means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

32. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprising a pair of rolls, means for rotatably supporting said rolls in an adjacent and operatively associated relation, a main bath of molten metal located above the bight of said rolls, an auxiliary bath of molten metal at each end of said rolls and contiguous with said main bath to restrain the same, substantially horizontal inlet channels connecting said auxiliary baths to each other and forming a closed circuit therewith, means for supplying molten metal to said main and auxiliary baths through said inlet channels, and means for rotating said rolls to cause the ejection of solidified metal from the bight thereof.

33. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprising a pair of rolls, means for rotatably supporting said rolls in an adjacent and operatively associated relation, a main bath of molten metal located above the bight of said rolls, an auxiliary bath of molten metal at each end of said rolls and contiguous with said main bath to restrain the same, substantially horizontal inlet channels connecting said auxiliary baths to each other and forming a closed circuit therewith, means for supplying molten metal to said circuit, induction heating means operatively associated with said circuit, and means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

34. A rolling mill for producing solid metal of substantially constant cross section throughout its length directly from a mass of molten metal comprising a pair of rolls, means for rotatably supporting said rolls in an adjacent and operatively associated relation, a main bath of molten metal located above the bight of said rolls, an auxiliary bath of molten metal at each end of said rolls and contiguous with said main bath to restrain the same, relatively narrow pouring channels having one of their ends connected to said auxiliary baths, a main inlet channel connected to the other ends of said pouring channels and forming a complete circuit including said main and auxiliary baths, means for feeding molten metal to said circuit, induction heating means operatively associated with said circuit, and means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

35. A rolling mill for producing solid metal of substantially constant cross sections throughout its length directly from a mass of molten metal comprising a pair of rolls, means for rotatably supporting said rolls in an adjacent and operatively associated relation, means for feeding molten metal into the bight of said rolls to establish a main bath of molten metal therein, an end dam at each end of said rolls constituted of a molten metal and having substantially the same height as the molten metal in said main bath, and means for rotating said rolls to cause the ejection of solidified metal from the bight of the rolls.

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