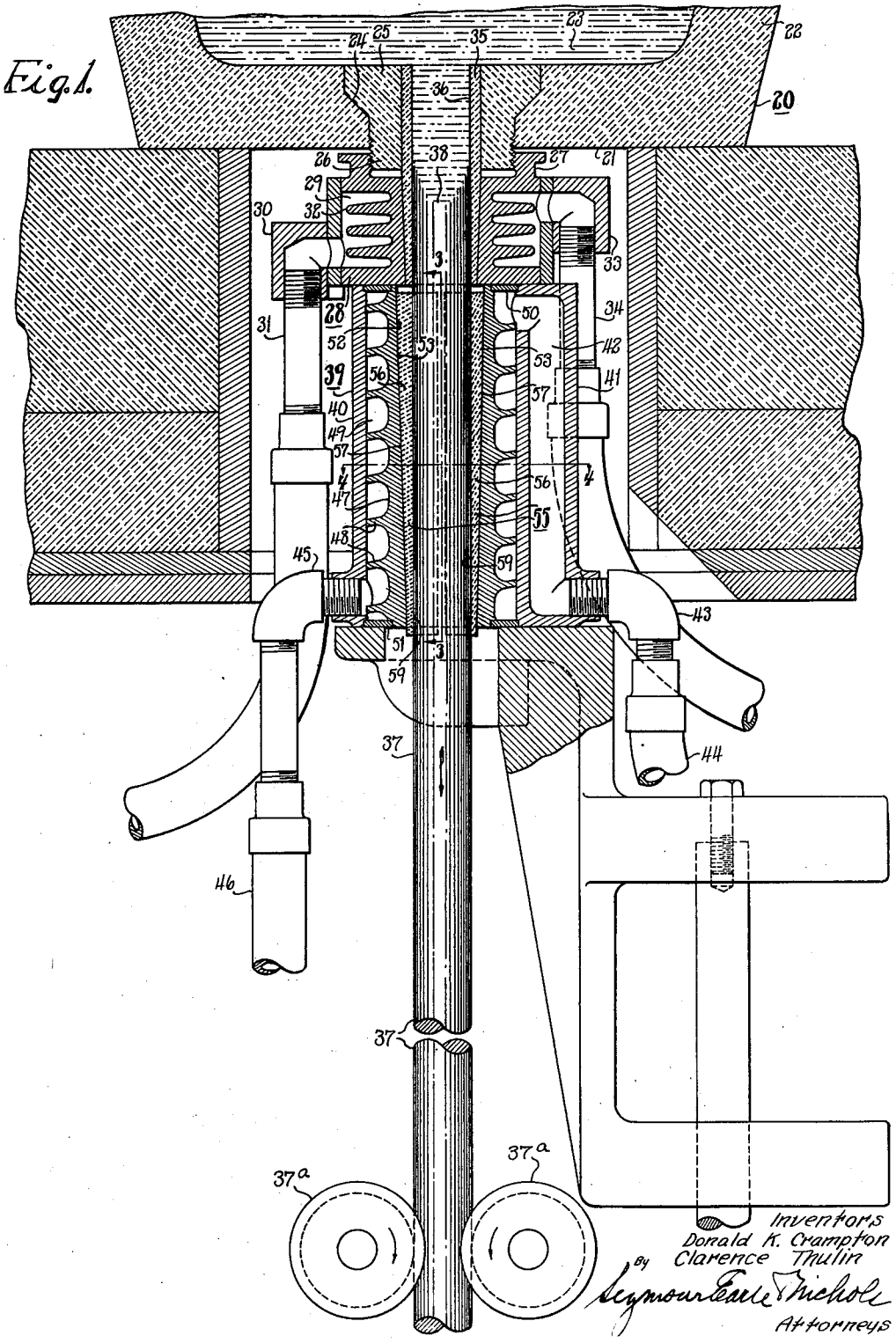
Aug. 15, 1939. D. K. CRAMPTON ET AL 2,169,893

COOLING MEANS FOR CONTINUOUS CASTING APPARATUS

Filed Nov. 1, 1937 3 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

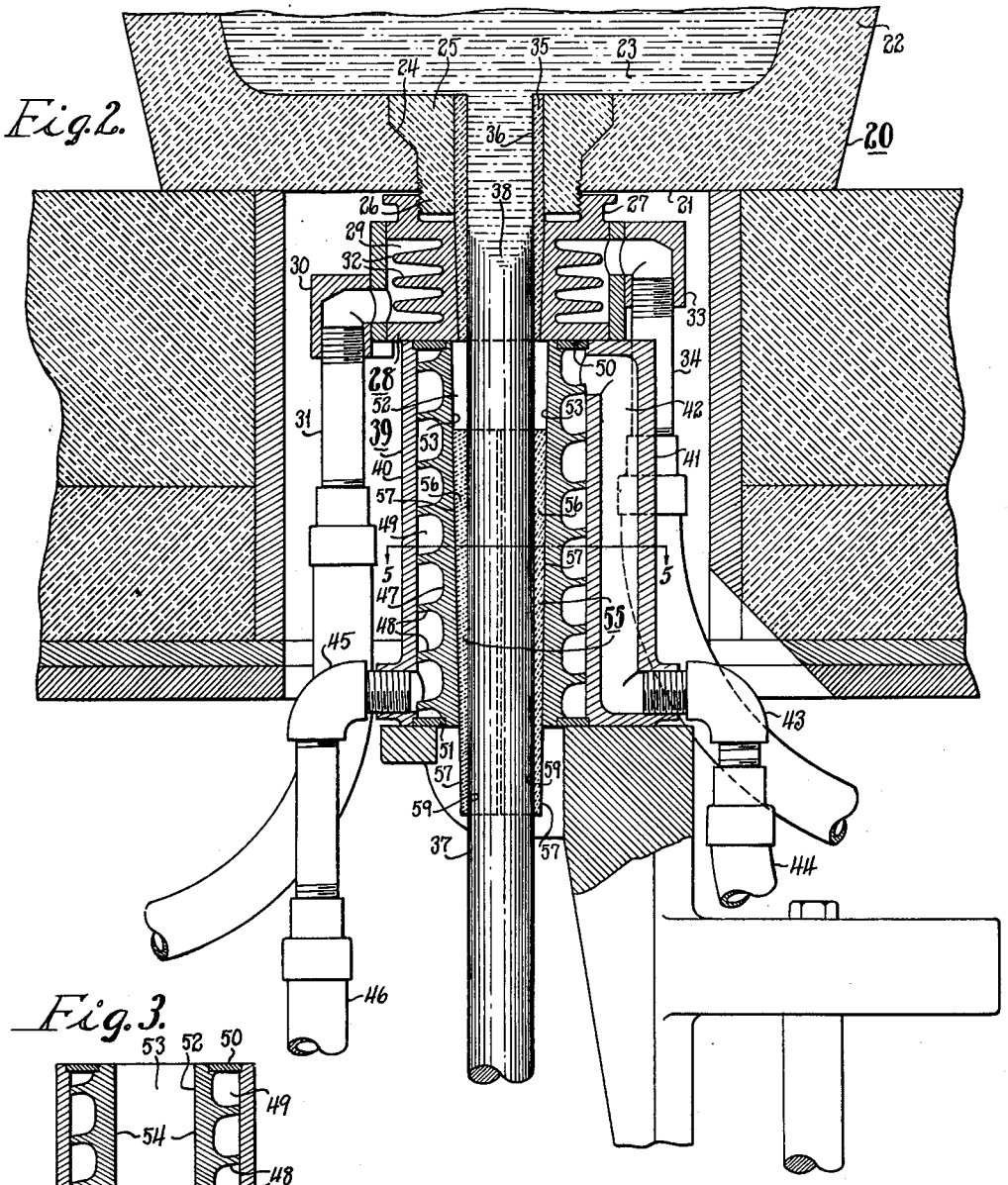
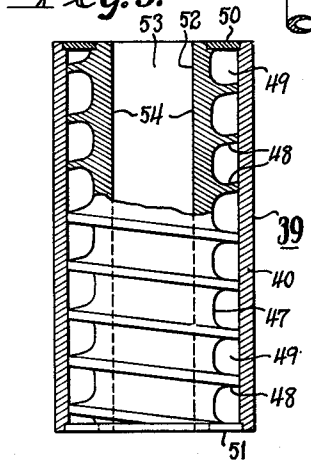


Fig. 3.



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Fig. 4.

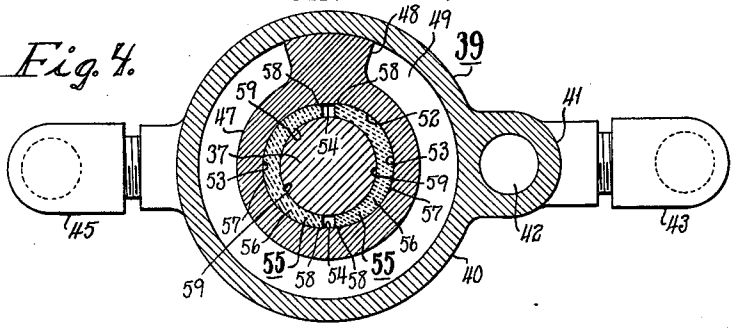


Fig. 5.

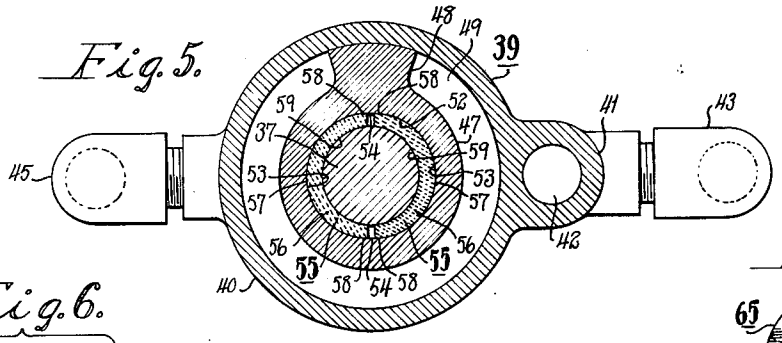


Fig. 6.

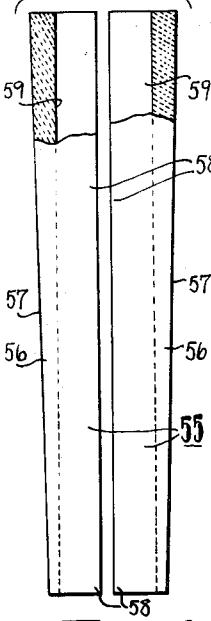


Fig. 7.

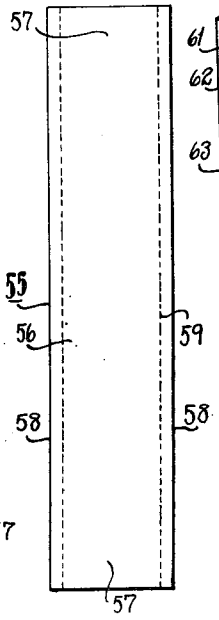


Fig. 8.

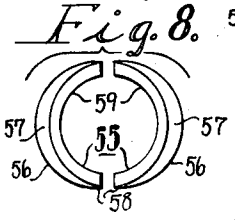


Fig. 9.

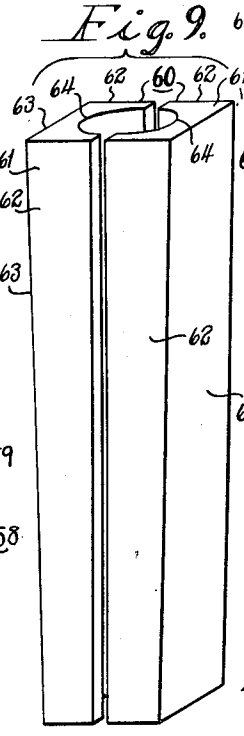


Fig. 10.

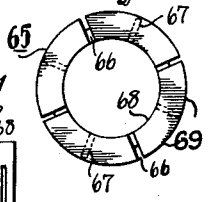


Fig. 11.

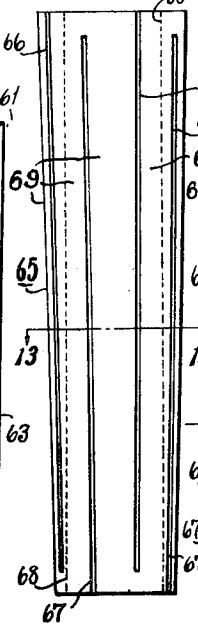


Fig. 13.

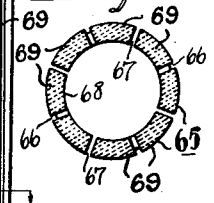
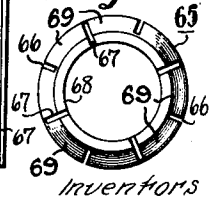


Fig. 12.



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UNITED STATES PATENT OFFICE

2,169,893

COOLING MEANS FOR CONTINUOUS CASTING APPARATUS

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Application November 1, 1937, Serial No. 172,082

9 Claims. (Cl. 22—57.2)

This invention relates to apparatus for continuously casting metal in the form of rods, bars, tubes or the like and relates more particularly to the means whereby the metal is cooled after it has solidified.

One of the objects of the present invention is to provide a continuous casting apparatus wherein superior means is provided for extracting heat from the previously cast metal.

Another object of the present invention is to provide superior cooling means for continuous casting apparatus wherein intimate thermal engagement with the previously solidified metal is assured despite wear and erosion occurring as an incident to the movement of the said metal with respect to the contacting surfaces of the cooling means.

With the above and other objects in view, as will appear to those skilled in the art from the present disclosure, this invention includes all features in the said disclosure which are novel over the prior art and which are not claimed in the following co-pending applications: Serial No. 157,644, filed August 6, 1937; Serial No. 159,672, filed August 18, 1937; Serial No. 171,188, filed October 27, 1937; and Serial No. 160,795, filed August 25, 1937.

In the accompanying drawings, in which certain modes of carrying out the present invention are shown for illustrative purposes:

Fig. 1 is a broken view mainly in vertical central section of an apparatus for continuously casting metal and embodying the cooling-means of the present invention;

Fig. 2 is a view corresponding to Fig. 1, but showing the downward movement of the heat-transmitting liner as an incident to wear upon its interior passage;

Fig. 3 is a detail sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is a transverse sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is a transverse sectional view corresponding to Fig. 4, but taken on the line 5—5 of Fig. 2;

Fig. 6 is a view mainly in side elevation and partly in vertical central section of the two elements of the heat-transmitting liner;

Fig. 7 is a view thereof taken at a right angle to Fig. 6;

Fig. 8 is an under-side view thereof;

Fig. 9 is a perspective view of another form of heat-transmitting liner;

Fig. 10 is a top-end view of still another form of heat-transmitting liner;

Fig. 11 is a view thereof in side elevation;

Fig. 12 is a view of the liner of Figs. 10 and 11, viewed from the lower end thereof; and

Fig. 13 is a transverse sectional view taken on the line 13—13 of Fig. 11.

The particular continuous casting apparatus herein chosen for the purpose of illustrating the present invention in Figs. 1 to 8 inclusive includes a cup-shaped container or crucible generally designated by the reference character 20 and which may be formed of a wide variety of suitable materials, such for instance as clay-graphite materials commonly used in the manufacture of crucibles and the like. The said container or crucible 20 includes a bottom wall 21 and an upstanding annular side wall 22 and if desired may be enclosed in a housing (not shown) so as to conserve the heat of the molten metal 23 located within the said crucible or container 20 before referred to.

In the particular structure shown, the bottom wall 21 of the container 20 is provided with a central shouldered aperture 24 in which is fitted a shouldered retaining-member 25 formed of refractory material and having an externally-threaded tubular shank 26 which projects below the under surface of the bottom wall 21 of the container as is shown particularly well in Figs. 1 and 2.

Threaded onto the downwardly-projecting portion of the externally-threaded shank 26 of the retaining-member 25 is the internally-threaded coupling-sleeve 27 of a primary cooling-chamber generally designated by the reference character 28. The said cooling-chamber is preferably formed of copper or other high heat-conducting material and is provided in its interior with a cooling-compartment 29 into which water or other suitable coolant may flow from a water-head 30 secured to the outer periphery of the said cooling-chamber and in turn supplied with a cooling fluid from a supply-pipe 31. After circulating through the cooling-compartment 29 in contact with the radiating or heat-exchange fins 32 projecting from the inner wall of the said chamber, the coolant passes outwardly through a water-head 33 and thence through an outlet-pipe 34.

Extending axially through both the retaining-member 25 and the cooling-chamber 28 in intimate thermal engagement therewith is a tubular forming-die 35 having an axial forming or casting passage 36 and formed of any suitable material which will withstand the heat of molten copper, brass or other metal, though it has been

found that for this purpose a very fine-grained graphite is preferable.

Owing to the action of the coolant flowing through the interior of the cooling-chamber **28**, in conjunction with the coolant flowing through secondary cooling-means to be later described, the molten metal within the forming-passage **36** will solidify or freeze as soon as sufficient heat has been extracted therefrom, before such molten metal can reach the lower end of the said passage **36** and emerge therefrom. For purposes of illustration, let it be presumed that the speed of withdrawal of the solidified metal in the form of a rod **37** by power-driven withdrawing-rolls **37ª—37ª** is such that the cooling-means is effective to cause the freezing or solidification to take place at about the point **38** in the said forming-passage **36**.

Coming now to the secondary cooling-means with which the present invention is mainly concerned, it may be stated that the said secondary cooling-means, one embodiment of which is to be presently described in detail, is designed to extract heat from the solidified rod **37** to thus assist the cooling action of the primary cooling-chamber **28** by causing heat to move axially down the solidified rod from the point of solidification **38** in the manner as will hereinafter appear.

The secondary cooling-means above referred to includes a cooling-chamber generally designated by the reference character **39** which is preferably formed of copper or other high heat-conducting material and comprises an outer tubular casing-member **40** having a longitudinal integral rib **41** on its exterior in which is formed a Z-shaped coolant-passage **42** opening into the interior of the casing-member **40** at the upper end thereof and connected at its lower end to an outlet-fitting **43** which latter in turn is connected to an outlet-pipe **44**, as shown in Figs. 1 and 2. At a point substantially diametrically opposite the outlet-fitting **43** just referred to the casing-member **40** has opening into its interior a coolant-inlet fitting **45** to which is connected a coolant supply-pipe **46**.

Snugly fitting within the outer casing-member **40** is an inner casing-member **47** formed on its exterior with a continuous helical rib **48** to facilitate the transfer of heat from the cooling-chamber **39** to the coolant and resulting in the formation between the convolutions of the said helical rib of what may be aptly termed a helical cooling-compartment **49** which is supplied at one end with a suitable coolant from the pipe **46** and from which such coolant may flow outwardly through the outlet-pipe **44** before referred to.

The upper end of the cooling-compartment **49** above referred to is sealed by an end-plate **50** and in a similar manner the lower end of the said cooling-compartment is closed by an end-plate **51**, both of which plates **50** and **51** extend between the outer casing-member **40** and the inner casing-member **47** and to which they are secured in a water-tight manner by brazing or other suitable means of attachment.

The inner casing-member **47** is formed with a central longitudinal passage **52** which is of special form and has two opposed wall-portions **53—53**, each of which is transversely curved and each of which converges toward the other as it approaches the lower end of the said inner casing-member **47**. The opposed diametrically-opposite wall-portions **54—54** which are located at a right angle to the aforesaid wall-surfaces **53—53** do not taper toward each other but are in parallelism, as is shown particularly well in Fig. 3.

Installed in the passage **52** in the inner casing-member **47** of the secondary cooling-chamber **39** is a laterally-contractable heat-transmitting liner generally designated by the reference character **55** and comprising two opposed liner-members **56—56** corresponding to each other and each having a wall-portion **57** which tapers downwardly and inwardly relative to the axis of the heat-transmitting liner as a whole and conforms to the adjacent one of the wall-surfaces **53** in the inner casing-member **47**. The exterior surfaces **58—58** of each of the liner-members **56** lying adjacent its respective opposite longitudinal edges are in substantial parallelism and conform to the wall-surfaces **54—54** of the inner casing-member **47**.

It is to be understood that the exterior surface of each of the liner-members **56** throughout their entire perimeter and length conform to the interior surfaces of the passage **52** in the inner casing-member **47** so as to be in intimate heat-conducting contact therewith throughout as large a surface-area as possible.

It will be noted from the accompanying drawings that the cross-sectional form of the liner-members **56—56** are of concavo-convex form and are thicker at their upper ends than they are at their lower ends save at their longitudinal edges where the thickness diminishes so that the wall-thickness along the said longitudinal edges is substantially the same throughout. The interior surface of each of the said liner-members **56** is of semi-circular form in cross-section and is designed to snugly fit the exterior surface of the cast rod **37** though if desired the radius of curvature at the bottoms of the said surfaces **59** may be slightly less than the radius of curvature of the upper end of the said surfaces so as to compensate for the lesser diameter of the rod **37** at its point of emergence from the liner **55** as compared to its diameter at its point of entrance into the said liner, owing to the shrinkage of the said rod due to its lower temperature at its said point of emergence.

As the cast rod **37** is drawn downwardly by the withdrawing-rolls **37ª—37ª** it will, owing to its frictional engagement with the inner surfaces **59** of the heat-transmitting liner **55**, tend to draw the said liner downwardly. This downward draft upon the liner as just referred to will in turn tend to more intimately engage its outer surfaces with the interior surfaces of the passage **52** in the inner casing-member **47** and also tend to move the inner surfaces **59** of the said liner-members into more intimate contact with the exterior surfaces of the rod **37**. This action being due to the tapered character of the passage **52** and the co-acting surfaces of the liner-members **56**.

As wear takes place, the heat-transmitting liner **55** may ultimately shift downwardly from the position in which it is shown in Fig. 1 into the position in which it is shown in Fig. 2, during all of which time, however, it will have maintained intimate thermal contact with both the rod **37** and the wall-surfaces of the passage **52** of the secondary cooling-chamber **39**. It will be noted by comparing Figs. 1 and 4 respectively with Figs. 2 and 5 that as the wear above referred to takes place, the longitudinal edges of the liner-members **56** will approach more closely to the similar edges of the complemental liner-member. This approach of the longitudinal edges of the liner-members will, of course, be gradual throughout the entire longitudinal movement thereof and in

effect constitutes a gradual contraction of the heat-transmitting liner viewed as a whole.

Various materials may be employed for use in the heat-transmitting liner **55** as well as in other heat-transmitting liners to be later described, though it is preferred to employ a very fine grained graphite since such material will withstand very high temperatures and will provide a minimum of frictional coefficient between its interior surfaces and the exterior surface of the rod **37** or other rod-like objects being cast.

In Fig. 9 is shown another form which a laterally-contractable heat-transmitting liner may assume in accordance with the present invention. The heat-transmitting liner of Fig. 9 is generally designated by the reference character **60** and includes two corresponding opposed liner-members **61—61** together providing a figure in cross-section which is substantially rectangular. Each liner-member **61** is provided with two opposite flat walls **62—62** which are parallel with each other and with a third exterior wall **63** extending between the two said walls **62** and tapering downwardly and inwardly toward the axis of the heat-transmitting liner **60** considered as a whole.

Each of the opposed liner-members **61—61** above referred to is formed in its interior with a longitudinal groove **64** which is of substantially-semicircular form in cross-section to snugly fit the exterior surface of a cast rod such as **37** before described. The liner-members **61** may be characterized as being of plano-concave form in cross-section in contradistinction to the liner-members **56** before described which are of concavo-convex form in cross-section.

It will, of course, be understood that the heat-transmitting liner **60** of Fig. 9 will be fitted within a correspondingly-shaped passage in a suitable cooling-chamber such as **39** before described.

In Figs. 10 to 13 inclusive is shown still another form of heat-transmitting liner which is generally designated by the reference character **65** and which has its exterior surface of conical form and which is of ring-shaped form in cross-section. The said heat-transmitting liner **65**, instead of being parted into physically-distinct members or elements to permit lateral contraction, is formed with two series of longitudinal slots **66** and **67** which provide for such contraction to maintain the surfaces of the cylindrically-contoured longitudinal passage **68** extending therethrough in snug engagement with the exterior surface of a cast rod such for instance as **37** before described. The series of longitudinal slots **66** intersect the upper end of the heat-transmitting liner **65** and extend in close proximity to the lower end thereof. On the other hand, the longitudinal slots **67** which are located intermediate the slots **66** above described intersect the lower edge of the heat-transmitting liner **65** and extend into close proximity to the upper edge thereof, which edge, however, the said slots **67** do not intersect. In this way, the heat-transmitting liner **65** is constructed to comprise a plurality of laterally-contractible members **69** extending longitudinally between the slots **66** and **67**.

The heat-transmitting liner **65** just above described will, like the other form of liners described, transversely contract as wear takes place in its passage **68** to maintain intimate thermal contact with a rod being cast and also with the surface of a conically-contoured passage in a suitable cooling-chamber of the general character of the passage **52** before described.

The invention may be carried out in other specific ways than those herein set forth without departing from the spirit and essential characteristics of the invention, and the present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

We claim:

1. A laterally-contractible heat-transmitting liner for use in the cooling-chambers of continuous casting apparatus, comprising a plurality of liner-members exteriorly tapered to conform to longitudinally-tapered passages in the said cooling-chambers and shaped interiorly to form a laterally-contractible longitudinal passage between them of substantially-uniform cross-sectional form throughout their length for the reception of rod-like cast-metal, the said liner-members being constructed to be arranged in contractible-engagement with the walls of said tapered passages with laterally-spaced longitudinal edge-portions providing longitudinal clearance-gaps therebetween to permit the transverse contraction of the said liner-members during the endwise movement of the heat-transmitting liner toward the contracted end of the said tapered passages.

2. Cooling-means for continuous casting apparatus having a molten metal container from which molten metal emerges in hot solidified rod-like form, comprising: a cooling-chamber having a compartment for the flow of a coolant therethrough and also having a tapered passage for the reception of a heat-transmitting liner; and a longitudinally-divided laterally-contractable heat-transmitting liner composed of a plurality of independently-movable liner-elements located in the tapered passage in the said cooling-chamber and exteriorly tapered to snugly fit the tapered surface of the said tapered passage, the said liner-elements of the heat-transmitting liner being spaced from each other to provide a passage between them for the reception of the rod-like metal from the said container and the said liner-elements being movable longitudinally toward the smaller portion of the tapered passage in the said cooling-chamber and movable laterally toward each other as such longitudinal movement takes place to maintain contact with the surface of the rod-like metal.

3. Cooling-means for continuous casting apparatus having a molten metal container from which molten metal emerges in hot solidified rod-like form, comprising: a cooling-chamber having a compartment for the flow of a coolant therethrough and also having a tapered passage having a greater diametrical extent in one direction as compared to its diametrical dimension at a right angle to the first said diametrical dimension, said tapered passage being adapted to receive a heat-transmitting liner; and a heat-transmitting liner comprising two opposed members of U-shaped form in cross-section and providing between them a passage for snugly receiving the rod-like cast metal coming from the said container, the said opposed members of the heat-transmitting liner snugly fitting the tapered passage in the said cooling-chamber and being movable longitudinally toward the contracted portion of the said tapered passage and laterally movable toward each other as such longitudinal move-

ment takes place to maintain contact with the surface of the rod-like metal.

4. Cooling-means for continuous casting apparatus having a molten metal container from which molten metal emerges in hot solidified rod-like form, comprising: a cooling-chamber having a compartment for the flow of a coolant therethrough and also having a passage for the reception of a heat-transmitting liner, the said passage having two opposite wall-portions which are longitudinally tapered toward each other and two other wall-portions which are substantially parallel; and a heat-transmitting liner comprising two opposed members providing between them a passage for snugly receiving the rod-like cast metal coming from the said container and each of the said members having oppositely-located wall-portions which are substantially parallel and also having a third wall-portion which is tapered to conform to the taper of one of the tapered wall-portion of the passage in the said cooling-chamber, the heat-transmitting members of the said heat-transmitting liner being movable longitudinally toward the contracted portion of the tapered passage in the said cooling-chamber and laterally movable toward each other as such longitudinal movement takes place to maintain contact with the surface of the rod-like metal.

5. Cooling-means for continuous casting apparatus having a molten metal container from which molten metal emerges in hot solidified rod-like form, comprising: a cooling-chamber having a compartment for the flow of a coolant therethrough, and also having a passage for the reception of a heat-transmitting liner, the said passage having two oppositely-located wall-portions which are longitudinally tapered and transversely curved and two other wall-portions which are substantially flat transversely and longitudinally parallel; and a heat-transmitting liner comprising two opposed members of U-shaped form in cross-section and providing between them a passage for snugly receiving the rod-like cast metal coming from the said container and each of the said U-shaped members having oppositely-located wall-portions which are substantially parallel, and also having an intermediate wall-portion which is transversely curved and which is tapered to conform to the taper of one of the tapered wall-portions of the passage in the said cooling-chamber, the U-shaped heat-transmitting members of the said heat-transmitting liner being movable longitudinally toward the contracted portion of the tapered passage in the said cooling-chamber and laterally movable toward each other as such longitudinal movement takes place to maintain contact with the surfaces of the rod-like metal.

6. A laterally-contractable heat-transmitting liner for use in the cooling-chambers of continuous casting apparatus, having an exteriorly-tapered surface designed to snugly fit the tapered surface of a cooling-chamber, and having an interior passage of substantially-uniform cross-sectional form throughout its length for the reception of rod-like cast metal, the said heat-transmitting liner also being formed with a plurality of longitudinal slots providing for the lateral contraction referred to.

7. A laterally-contractable heat-transmitting liner for use in the cooling-chambers of continuous casting apparatus, comprising a plurality of independently- movable liner-elements shaped interiorly to form a laterally-contractable longitudinal passage between them of substantially-uniform cross-sectional form throughout its length for the reception of rod-like cast metal, the said heat-transmitting liner having opposed exterior surfaces tapering toward each other, and also having opposed exterior surfaces at a right angle to the said tapered surfaces and extending substantially parallel with each other.

8. A laterally-contractable heat-transmitting liner for use in the cooling-chambers of continuous casting apparatus, comprising a pair of independently movable liner-elements, each of U-shaped form in cross-section and arranged to provide an interior longitudinal passage between them of substantially-uniform cross-sectional form throughout their length for the reception of rod-like cast metal, each of the said liner-elements having longitudinal edge-portions on the opposite sides of the passage therethrough, which edge-portions are in substantial parallelism, the longitudinal exterior surface of the liner-elements intermediate the aforesaid edges being tapered.

9. A laterally-contractable heat-transmitting liner for use in the cooling-chambers of continuous casting apparatus, having an exteriorly-tapered surface designed to snugly fit the tapered surface of a cooling-chamber and having an interior passage of substantially-uniform cross-sectional form throughout its length for the reception of rod-like cast metal, the said heat-transmitting liner also being formed with two sets of longitudinal slots, one set of which intersects the upper end of the liner and extends to a point adjacent the lower edge thereof without intersecting the same, and the other set of said longitudinal slots intersecting the lower end of the liner and extending into a position adjacent but not intersecting the upper end of the liner.

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