

Aug. 5, 1924.

1,503,479

A. COATS
PROCESS AND APPARATUS FOR THE CONTINUOUS CASTING OF RODS,
BARS, AND THE LIKE
Filed Dec. 2, 1919

3 Sheets-Sheet 1

FIG: 1.

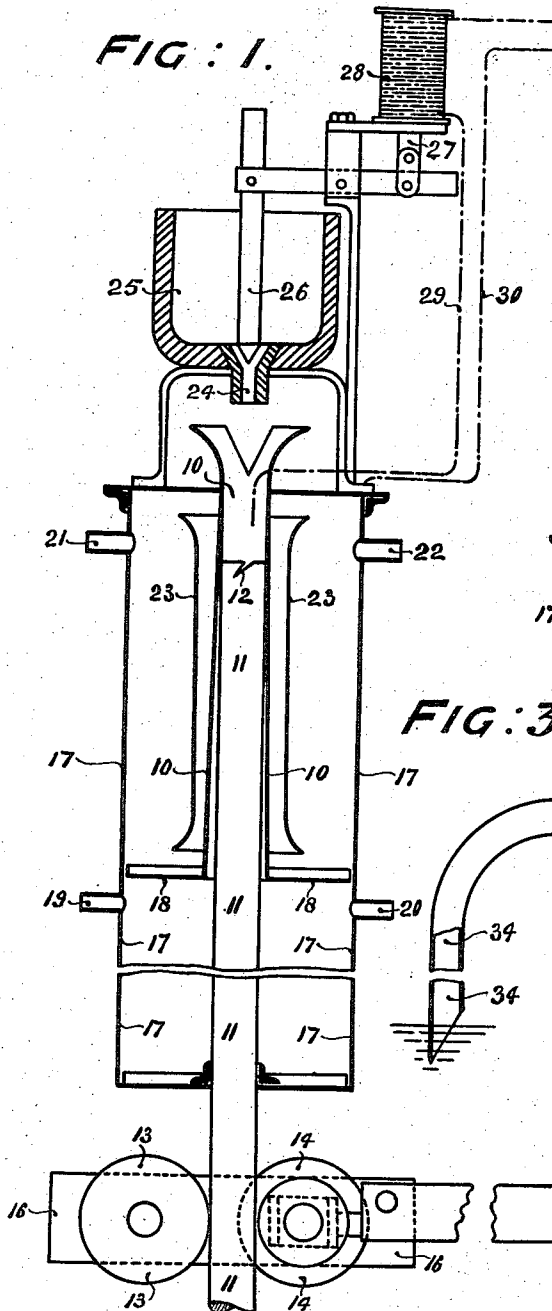


FIG: 2.

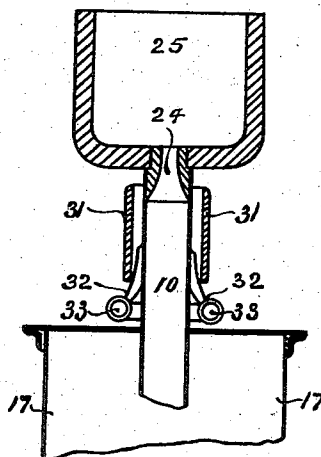
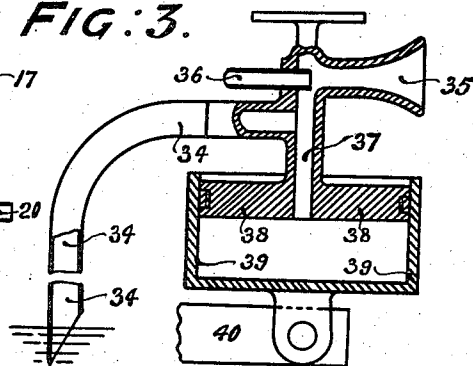


FIG: 3.



Inventor

Allan Coats,

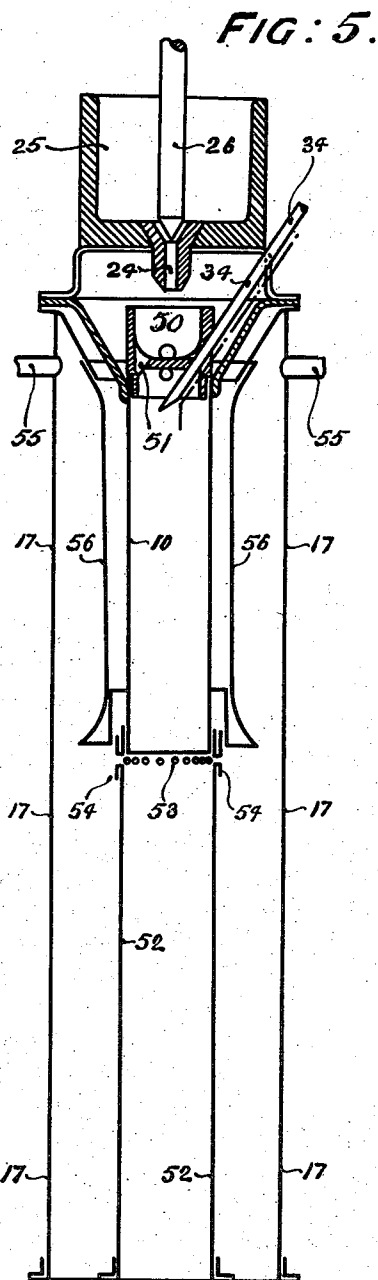
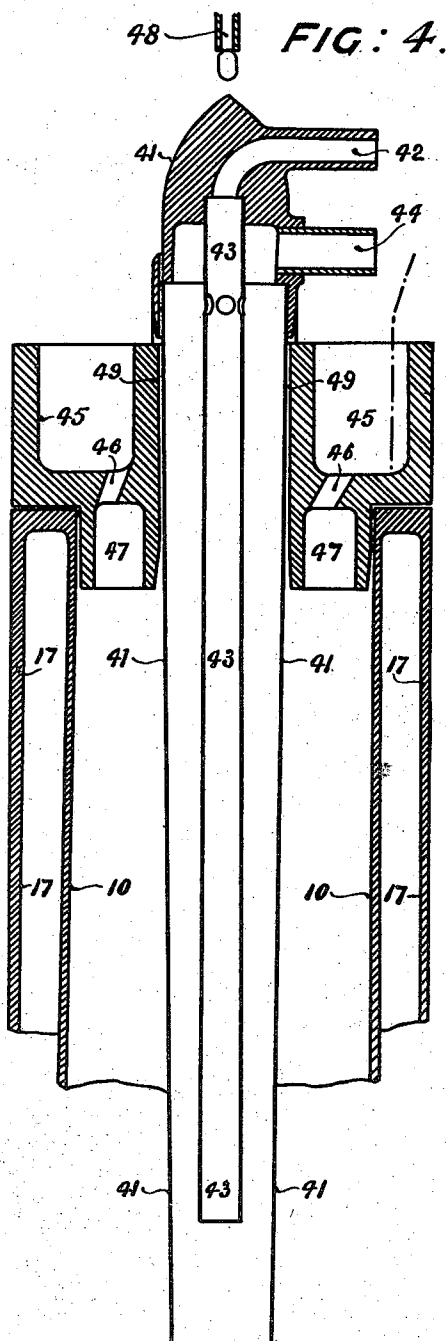
by Russell M. Everett,
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3 Sheets-Sheet 2



Inventor:

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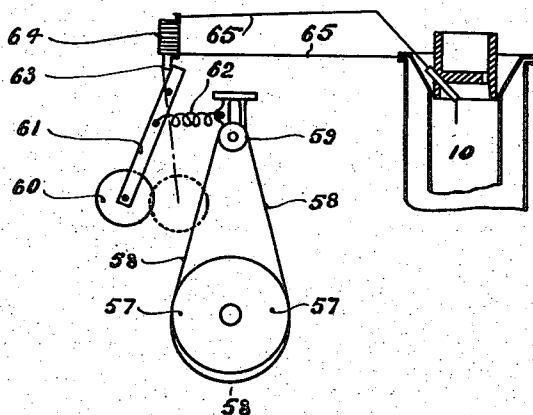
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3 Sheets-Sheet 3

FIG : 6.



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Patented Aug. 5, 1924.

1,503,479

UNITED STATES PATENT OFFICE.

ALLAN COATS, OF CASTLEHEAD, PAISLEY, SCOTLAND.

PROCESS AND APPARATUS FOR THE CONTINUOUS CASTING OF RODS, BARS, AND THE LIKE.

Application filed December 2, 1919. Serial No. 341,918.

To all whom it may concern:

Be it known that I, ALLAN COATS, a subject of the King of Great Britain and Ireland, and a resident of Hayfield, Castlehead, Paisley, Scotland, have invented a certain new and useful Improved Process and Apparatus for the Continuous Casting of Rods, Bars, and the like, of which the following is the specification.

The invention has for its object an improved process of and apparatus for continuously casting metal rods, bars, tubes and the like of circular, angular or other solid or hollow section.

According to the invention, there is provided a casing of tubular form of some length, the walls of which are comparatively thin. This tubular casing which conforms internally to the section of the rod or bar to be formed is provided with means for cooling its lower part.

So carried, that it may be inserted within and withdrawn from, the lower end of the tubular casing by mechanical means, is a member which may be provided at its upper end with means to engage the molten metal as it solidifies, which molten metal is poured from a crucible or other vessel into the top end of the casing, the member being slowly withdrawn meanwhile.

It is important that there should be a zone of liquid metal between the crucible and that part of the rod which is solidified. This may be brought about by arranging the crucible at a sufficient height above the casing, so that the molten metal falls from thence through the air, or through a non-oxidizing atmosphere maintained in a casing enclosing that space.

Or alternatively the crucible or other pouring vessel may be directly connected to the top of the casing which at that part may be exposed above the cooling element (so that the necessary heat may be retained in the metal) while in addition this part of the casing may be externally heated.

When the crucible or pouring vessel is above the end of the casing, the discharge of molten metal from it is controlled by a valve in suchwise as to maintain a proper level of the metal in the casing. This valve may be hand-operated, or may be controlled by any convenient known means, such for example, as a solenoid the operative circuit

of which is made and broken by the rise and fall of the metal in the casing, or by a fluid pressure operated cylinder and piston, the flow to or discharge of pressure fluid from which is controlled by the rising metal, (the fluid used may be a non-oxidizing gas).

Or instead of the flow of metal being regulated, the level may be maintained by the variation of the rate at which the solidified rod is withdrawn.

The level of the molten metal in the crucible may be maintained constant by any convenient known means.

The internal surface of the casing is smooth and preferably highly polished. Its walls for the casting of some metals (lead, for example) may be parallel, but preferably it is so tapered at the upper part that its area increases downwardly.

When the crucible is at a distance above the end of the casing, the latter may be provided with a V or other discharge lip or notch to act as an overflow. The remainder of the upper periphery of the casing may be outwardly flared so that lubricant may be introduced around the rod being formed.

Around the periphery of the casing there may be a series of small apertures at or below that point where a solidified skin begins to form on the rod for the purpose of the more rapid cooling thereof. Lubricant may be supplied through these apertures.

The casing may either extend downwards beyond the cooling jacket which embraces its lower part, or may open into a vessel containing cooling liquid and forming the jacket, the hot rod being thus delivered from the lower end of the casing directly into the cooling liquid. Means for regulating the level of the liquid in this vessel may be provided.

Means are provided to ensure that the mechanism employed to effect the lowering of the central rod should begin to operate immediately the pouring of the metal is started. For example, the metal in the pouring vessel may be utilized to complete an electric circuit controlling the starting of a motor acting through gearing (which may be interchangeable) on the lower projecting end of the rod to withdraw the same at the rate desired.

In some cases,—for example, in the case of heavy sections of rod not readily bend-

able, it is more convenient that the casing should be inclined to the vertical, or approaching the horizontal.

The method and apparatus is applicable not only to rod-like sections but to flat plate-like sections and to tubes of circular or other section of considerable length.

When the apparatus is employed for the production of tubes or other hollow sections or objects, there is provided a mandrel within the casing and of such form and dimensions that the annular space between it and the casing is of the form of the section required. This mandrel extends into the zone of unsolidified metal and adjacent to the crucible, is supported from its upper end, may be hollow, and be provided with internal means for its cooling, and may also be provided with means for the lubrication of its exterior. The mandrel is preferably so tapered as to free the tube as it descends.

It is of advantage that the means for the discharge of the molten metal from the pouring vessel should be such that instead of a stream of molten metal being delivered at one point—say, the centre of the casing—it is delivered simultaneously at a number of points around and near the periphery of the casing, that is, near the periphery of the rod or tube being formed. This method of pouring has several advantages. For example, it facilitates the descent of the rod through the casing, as the momentum of the falling metal, impacting on the outer shell of the rod while solidifying, tends to force it down and thereby aids in preventing the shell from adhering to the casing. Also, as the direction of flow of the metal in the casing before solidification takes place is reversed from that which takes place when the usual method of pouring into the centre of the casing is adopted, the occluded gases can more readily ascend to the surface of the molten metal and escape. It also ensures a better mixing of the metal and thereby tends to prevent segregation of the impurities into one part of the rod being cast, which is apt to take place when central pouring is adopted.

In working and before commencing operations, it is of course necessary that the crucible or pouring vessel and the upper part of the casing should be raised to such a temperature as to avoid chilling of the molten metal.

The mechanism withdrawing the rods or the like being cast from the lower end of the casing, may also be such as will roll the metal to a smaller section.

A series of illustrative examples of varying forms of the apparatus are shown—to an extent diagrammatically—upon three accompanying sheets of explanatory drawings, Figure 1, being a sectional elevation of an arrangement of apparatus for casting

rods (Figures 2 and 3 being sectional elevations respectively of an alternative form of pouring vessel and of alternative means for controlling the flow of molten metal) while Figure 4, is a section elevation of the upper part of an apparatus for the casting of tubes or other hollow bodies, Figure 5 a like view of an alternative form of rod casting apparatus and Figure 6, a diagram of certain devices in connection with the withdrawal of the rod or other object.

In the example of apparatus shown in Figure 1, which is adapted for the casting of rod of circular section, there is provided a circular casing 10 in which casting takes place. It is flared outwards and split at its upper end to allow of oil being dripped on to the flared part, and at its lower end is of slightly greater area than that of its upper end, and so of the rod being cast and which in descending therefore clears it. Within the casing is a rod 11 provided at its upper end with a diametral V-groove 12 which is engaged by the lower end of the column of cast metal. The rod 11 is withdrawn at substantially the same rate as the molten metal enters the tube 10 by a pair of rolls 13, 14, the one 13 of which is driven and the other of which, V-grooved on its periphery, is forced into engagement with the rod 11 (and afterwards the rod of cast metal) by a weight 15 on the pivoted bracket 16 in which the roll 14 is carried.

The casing 10 is surrounded by a water jacket 17 which extends below it. This water jacket is divided by a partition 18 into two portions—a lower portion into which circulating water is admitted by a pipe 19 and discharged by a pipe 20, and in which the water has direct access to the cast rod immediately it emerges from the casing 10—and an upper portion where water enters and leaves by pipes 21, 22, and is in contact with the exterior of the casing 10, a current over the surface of which is maintained by a circulating sleeve 23.

The metal to be cast is delivered to the casing 10 from a nozzle 24 in the bottom of a pot or crucible 25 supported over the upper end of the casing. The rate of its discharge is regulated by a conical valve 26 which is controlled in any known manner by a solenoid 27 operated by a coil 28 the circuit of which is closed by way of wires 29, 30, when the metal rises into contact with the end of the wire 29 which projects the requisite distance into the mouth of the casing 10. Thus, when the molten metal attains that level and closes the circuit, the solenoid rises pushing down and closing the valve 26, and when the level of the metal falls breaking the circuit, the solenoid falls raising the valve and permitting more metal to flow.

In Figure 2 is shown an alternative form

of pouring device. In this case, the upper end of the casing 10 extends up to and embraces the nozzle 24 of the pot 25. Its upper end is enclosed in a sleeve 31 between which and the casing a series of gas burners 32 served by a pipe 33 are provided for heating purposes.

In Figure 3 is shown a device for controlling the valve 26 alternative to that electric one first described. In this form of device a pipe 34 is so placed that the molten metal may rise to submerge its lower end. In this pipe a partial vacuum is induced by an ejector device 35 operated by steam or other fluid in a jet nozzle 36. The throat of the ejector device not only communicates with the pipe 34 but with a passage 37 extending to the under side of a fixed piston 38 on which there slides a cylinder 39. So long as the pipe end 34 is unsubmerged, the vacuum is broken, but when the pipe end is submerged, the partial vacuum produced by the nozzle 35 raises the cylinder 39. This cylinder is operatively connected to the valve 26 by a pivoted lever 40.

In Figure 4 is shown in part an arrangement for casting tubes or other hollow bodies. In this example the casing 10 is surrounded as before by a water jacket 17, has supported from its upper end and coaxially within it, a hollow mandrel 41 internally cooled by water delivered to it by a pipe 42 flowing down towards its lower end by way of a pipe 43 and discharging again at its upper end by way of a pipe 44. At the upper end of the casing 10 and surrounding the mandrel 41 is an annular pouring gutter 45 into which molten metal is delivered from the crucible or pot. Apertures 46 in this gutter communicate with an annular nozzle 47 within the upper end of the casing 10 and from which the molten metal is finally delivered to the casing. Lubricant is delivered on to the conical head of the mandrel 41 by a pipe 48 and finds its way by grooves 49 past the pouring gutter 45 to the outer surface of the mandrel.

It will be noted that one of the apertures 46 discharges the molten metal along the outer wall of the annular nozzle 47, so that it is poured in a stream closely adjacent to the outer wall of the casing 10 and thus tends to free the metal therefrom as has already been described. The other of the apertures 46 which are shown in section in Figure 4 delivers the molten metal against the inner wall of the annular nozzle 47 so that it is poured adjacent the mandrel 41 and tends to free the metal therefrom. There is an annular series of each kind of apertures 46, and thus the metal is poured in two rings, one near the outer periphery of the tube being cast and the other near the inner periphery of it; this causes the flow of metal to be downward at said pe-

ripheries and upward midway between the two.

The apparatus for casting rods and the like shown in Figure 5 differs in detail from that first described. In it there is provided at the upper end of the casing 10 a pot 50 receiving molten metal from the nozzle 24 of the crucible 25 and distributing it by way of a series of discharge apertures 51 around the periphery of the rod being formed, analogous to the peripheral pouring above described in connection with Figure 4. The pipe 34 of the pneumatic valve control device shown in Figure 3 extends in through the wall of the pot. The water jacket 17 is provided at its lower part with a tube 52 extending up to and embracing the lower end of the casing 10. Around the upper end of this tube 52 is a series of apertures 53 controlled by a "hit-and-miss" ring 54 and allowing the cooling water to impinge upon the newly formed rod. Water enters and leaves the casing by way of pipes 55, a head being preferably maintained in both pipes. It also circulates between the casing 10 and a circulator sleeve 56 embracing that casing, and finds an outlet around the upper periphery of the casing.

In Figure 6 is diagrammatically shown a device for starting the withdrawing movement of the rod 11 (Figure 1) at the proper moment. This device consists of a pulley 57 driving by way of a slack belt 58, the pulley 59 driving the rod withdrawing means. This belt is tensioned by a jockey pulley 60 carried in a swing bracket 61 and urged against it by a spring 62. Normally the pulley 60 is held out of engagement with the belt by a detent 63 controlled by a solenoid 64 the circuit 65 of which is controlled by the rise of molten metal in the casing 10 after the manner described with reference to Figure 1, so that when the metal rises it closes the circuit of the solenoid, releases the detent and frees the jockey pulley to engage the belt.

What I claim is:—

1. In apparatus of the class described, the combination of a mold, and means for pouring molten metal into said mold in a stream between the middle of the mold and its wall and adjacent the latter.

2. In apparatus of the class described, the combination of a mold, and means for pouring molten metal into said mold between the middle of the mold and its wall and adjacent the latter along a line substantially parallel thereto.

3. In apparatus of the class described, the combination of a mold, and means for supplying molten metal to said mold at a plurality of spaced points between the axis of said mold and the inner walls thereof.

4. In apparatus of the class described, the combination of a circular mold, and means

for supplying molten metal to said mold at a plurality of annularly spaced points between the axis of said mold and the inner walls thereof.

5 5. In apparatus of the class described, the combination of a mold, and means for pouring molten metal into said mold at a plurality of spaced points between the middle of the mold and its wall and adjacent the latter along a line substantially parallel thereto.

15 6. In apparatus of the class described, the combination of a circular mold, and means for pouring molten metal into said mold at a plurality of annularly spaced points between the middle of the mold and its wall and adjacent the latter.

20 7. In apparatus of the class described, the combination with a mold, of a distributing pot for delivering molten metal into said mold, said pot being formed with a discharge opening conforming to the periphery of the article to be cast in the mold for distributing the molten metal around the periphery of said article.

30 8. In apparatus of the class described, the combination with a circular mold, of a distributing pot for delivering molten metal into said mold, said pot being formed with a plurality of annularly spaced discharge openings.

35 9. In apparatus of the class described, the combination with a circular mold, of a distributing pot for delivering molten metal into said mold, said pot being axially arranged over said mold and being provided with a plurality of discharge openings between its axis and its outer walls.

40 10. In apparatus of the class described, the combination with a circular mold, of a distributing pot for delivering molten metal into said mold, said pot being axially arranged over said mold and being provided with an annular series of discharge openings between its axis and its outer walls.

45 11. The method of continuous casting which consists in pouring molten metal into one end of a mold in a stream between the middle and wall of said mold adjacent said wall thereof, and synchronously withdrawing the solidified object from the other end of said mold.

50 12. The method of continuous casting which consists in pouring molten metal into one end of a mold between the middle and wall thereof adjacent the latter and along a line substantially parallel thereto, and synchronously withdrawing the solidified object from the other end of said mold.

55 13. In apparatus of the class described, the combination of a mold, and means for supplying molten metal to said mold at a plurality of annularly spaced points in said mold.

60 14. The method of pouring molten metal

into a mold consisting in directing a plurality of annularly spaced streams of molten metal into the mold.

15. In apparatus of the character described, the combination of a mold, means 70 for supplying molten metal to one end thereof, means for supplying lubricant directly to the article formed in said mold at a point in said mold at or below that at which solidification of the metal commences, and means 75 for continuously withdrawing the article formed in said mold.

16. In apparatus of the class described, the combination of a mold, a mandrel fixedly supported in said mold from the ingoing end 80 thereof and having an exterior configuration conforming to the interior of the article to be cast, means for supplying molten metal to said mold around the mandrel, means for continuously supplying a cooling liquid to 85 the interior of said mandrel, and means for continuously withdrawing the article formed in said mold.

17. In apparatus of the class described, the combination of a mold, a mandrel arranged in said mold and spaced from the interior walls thereof, means for pouring 90 molten metal into said mold around the peripheries of the mold and said mandrel, and means for continuously withdrawing 95 the article formed in said mold.

18. In apparatus of the class described, the combination of a mold having the interior walls thereof tapered, means for supplying molten metal to the small end of said 100 mold, and means for continuously withdrawing the article formed in said mold from the large end thereof.

19. In apparatus of the class described, the combination of a mold having its interior walls longitudinally tapered, means 105 for supplying molten metal to the small end thereof, and means for withdrawing the cast article from the opposite end thereof.

20. In apparatus of the class described, the combination of a mold the interior walls of which conform at one end to the cross-section of the article to be cast, said walls tapering to provide a greater cross-sectional area in the mold toward the opposite end thereof, 115 means for supplying molten metal to the first-mentioned end of said mold, and means for withdrawing the cast article from the said second-mentioned end.

21. In apparatus of the class described, the combination of a stationary mold the interior of which at one end thereof conforms to the cross-section of the article to be cast and increases in cross-sectional area toward the other end of said mold, means for supplying 125 molten metal to said first-mentioned end of the mold, and means for withdrawing the cast article from the said second-mentioned end of the mold.

22. In apparatus of the class described, the 130

combination of a circular tubular mold having the interior walls thereof longitudinally tapered, means for supplying molten metal to the small end of said mold, and means
5 for withdrawing the cast article from the opposite end of said mold.

23. In apparatus of the class described, the combination of a circular tubular mold having the interior walls thereof longitudi-
10 nally tapered and polished, means for supplying molten metal to the small end of said mold, and means for withdrawing the cast article from the opposite end of said mold.

24. In apparatus of the class described,
15 the combination with a mold, means for supplying molten metal to said mold, and means for withdrawing the cast article from the mold, of means controlled by the level of metal in the mold for controlling the opera-
20 tion of said article withdrawing means.

25. In apparatus of the class described, the combination with a mold, and means for supplying molten metal to said mold, of means controlled by the level of metal in the
25 mold for withdrawing the cast article from the mold.

26. In apparatus of the class described, the combination with a mold, means for supplying molten metal to said mold, and means
30 for withdrawing the cast article from the mold, of driving means for said article withdrawing means, and means controlled by the level of the metal in the mold for throwing said driving means into operation.

35 27. In apparatus of the class described, the combination with a mold, means for supplying molten metal to said mold, and means for withdrawing the cast article from the mold, of means for automatically throw-
40 ing said article withdrawing means into operation when the metal in the mold reaches a predetermined level.

28. In apparatus of the class described, the combination with a mold and means for
45 supplying molten metal to said mold, of a pair of relatively movable members with a chamber between the same, one of said members having a passage communicating between the atmosphere and said chamber, said
50 passage also communicating with the atmosphere above the metal in said mold, and means for normally drawing fluid through said passages, the metal in said mold when it reaches a predetermined level serving to
55 close communication between the atmosphere in the mold and said passages to cause exhaustion of the fluid in said before-mentioned chamber and produce relative movement of said pair of members.

29. In apparatus of the class described,
60 the combination with a mold and means for supplying molten metal to said mold, of a pair of relatively movable members one of which is provided with a chamber to tele-
65 scopically receive the other of said members, said second-mentioned member having a passage communicating between said chamber and the atmosphere, said passage also communicating with the atmosphere above
70 the metal in the said mold, and means for normally circulating fluid through said passages, the metal in said mold when it reaches a predetermined level serving to close communication between the atmosphere in the
75 mold and said passages to cause exhaustion of the fluid in said chamber and produce relative movement of said members.

30. In apparatus of the class described, the combination with a mold and means for supplying molten metal to said mold, of a
80 cylinder-and-piston device operatively connected to a valve controlling the discharge of molten metal into said mold, and an orifice so arranged as to be closed by the molten metal as it rises in said mold and control-
85 ling the supply of operating fluid to said cylinder and piston device.

31. The process of continuous casting consisting in continuously supplying molten
90 metal to one end of a mold around the periphery of the object being cast and continuously withdrawing the solidified object from the other end of the mold, a zone of fluid metal being maintained between the supply of the molten metal to the mold and
95 the solidifying metal therein.

32. Apparatus for the continuous casting of rods, bars and the like comprising a casing conforming internally to the cross-section of the object to be cast and of smooth
100 and preferably highly polished internal surface, means for the supply of molten metal to one end thereof, a temporary support for the initial formation of the rod bar or the like gradually withdrawable from the other
105 end thereof, means for firstly withdrawing the support and thereafter continuously withdrawing the formed rod or the like, means of substantially known kind for maintaining requisite temperatures of the
110 casing and metal at the various parts thereof, and means of substantially known kind for controlling the rate of flow of molten metal or the rate of withdrawal of the rod or both, as set forth.

In testimony whereof I have signed my name to this specification.

ALLAN COATS.