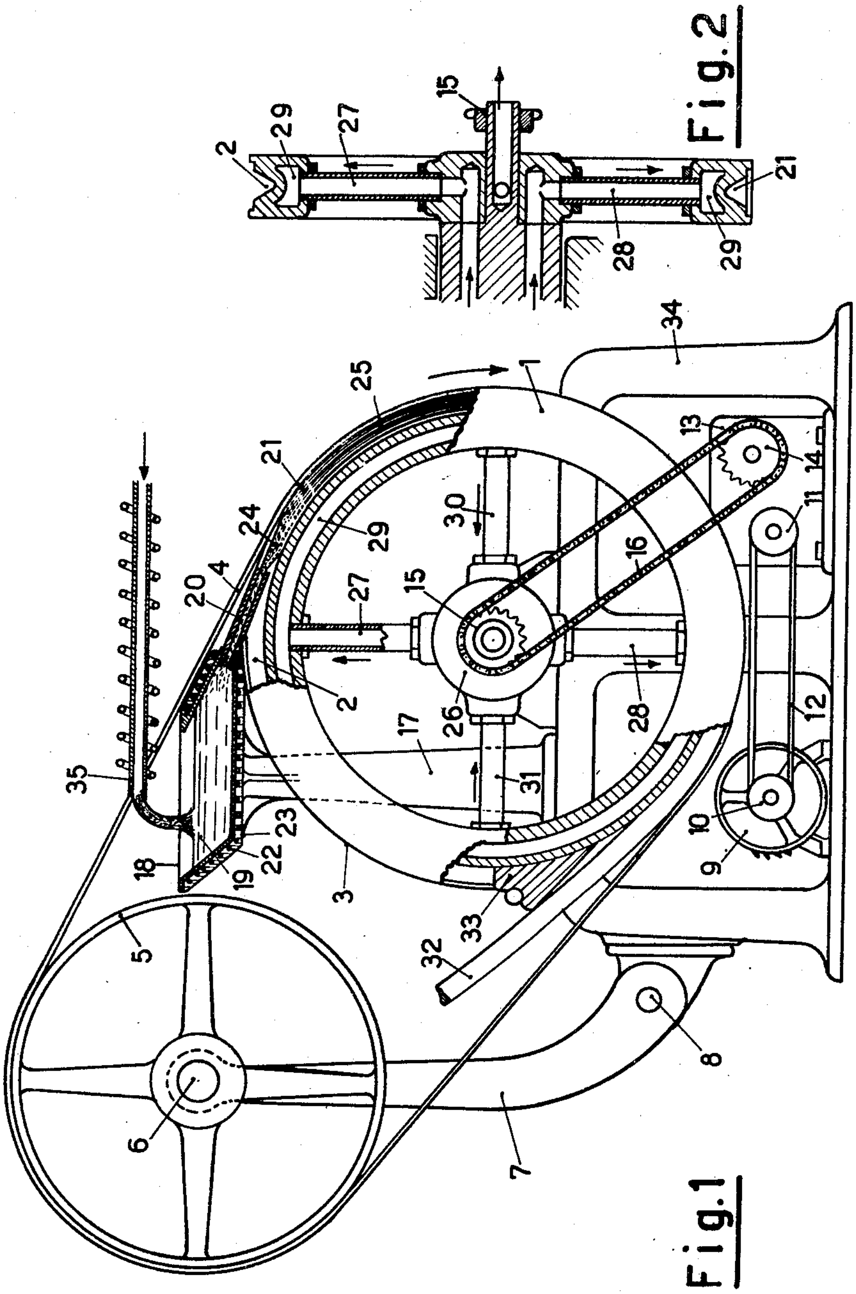
June 14, 1955 I. PROPERZI 2,710,433

CONTINUOUS METAL CASTING MACHINE

Filed Feb. 25, 1949 3 Sheets-Sheet 1



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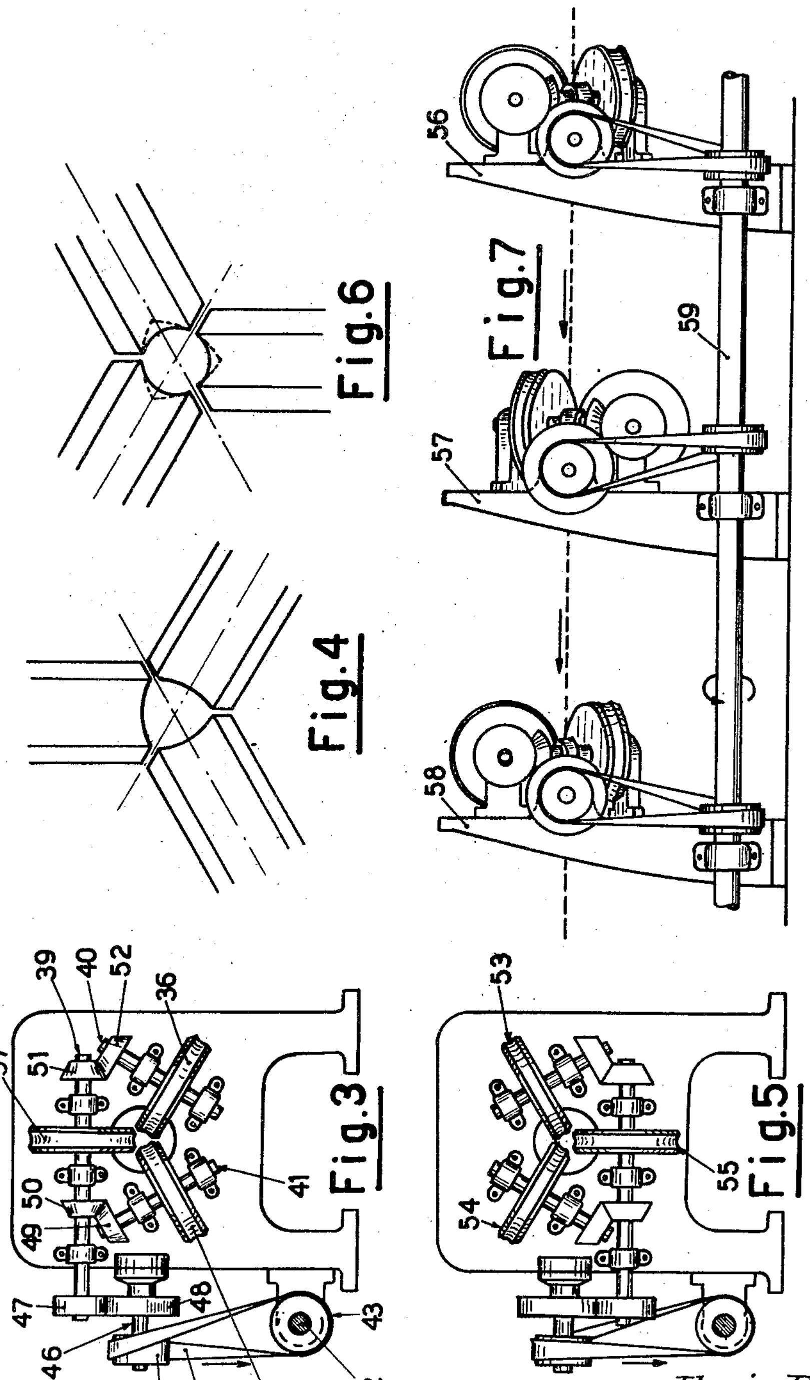

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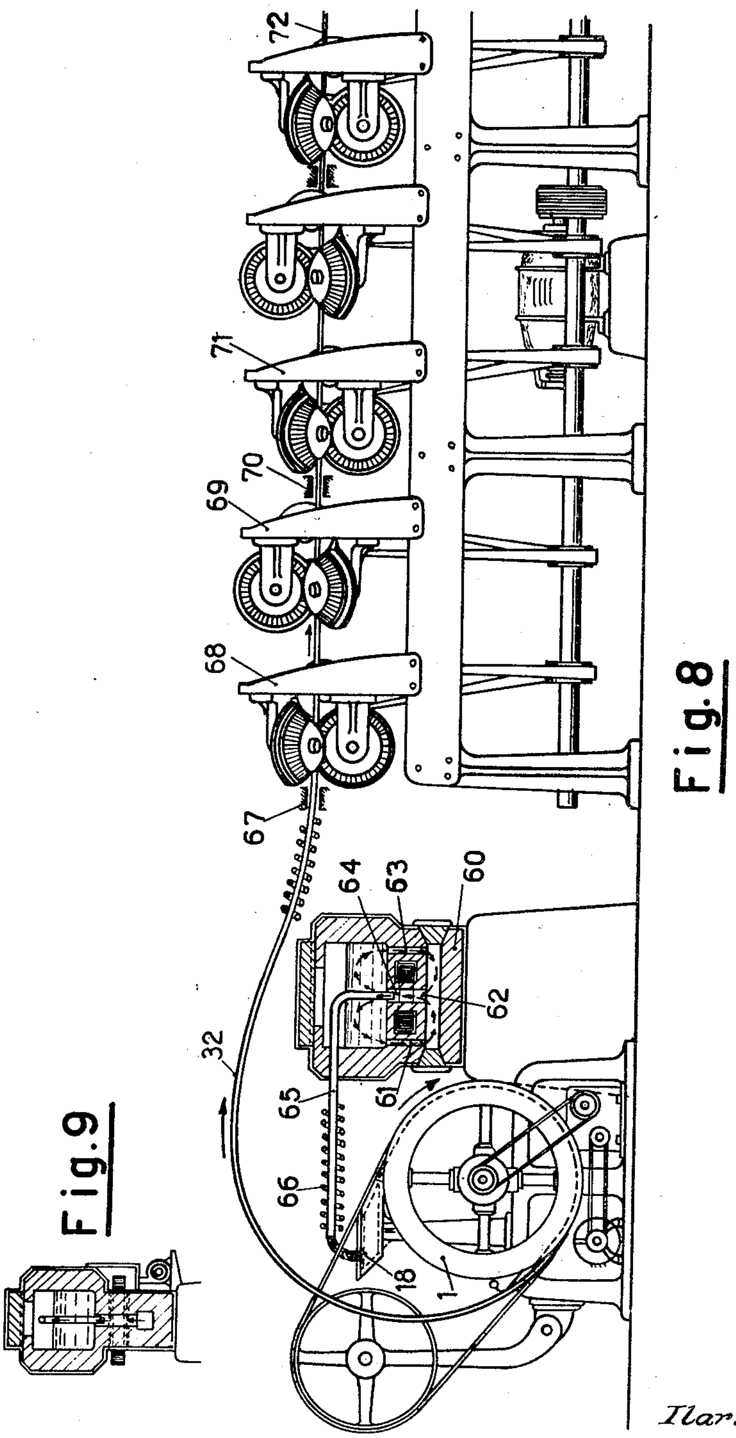

Fig. 8

Fig. 9

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CONTINUOUS METAL CASTING MACHINE

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2 Claims. (Cl. 22—57.4)

The present invention relates to an improved casting mechanism for continuously transforming molten metal into a cast rod.

For the production of rolled metal wire, from which finished metal wires are obtained by subsequent drawing operation, the primary materials used at present are big ingots generally obtained by smelting.

These ingots are then subjected to plastic reduction working by various means such as rolling mills, extrusion presses etc.; but as they must be of restricted length, the whole working process becomes intermittent with passive times, discarded work, notable employment of labour and heavy and costly machinery and, therefore, affects in a negative sense production cost, quality of products and the possibilities of extending this work to small and medium industries. It is an object of the present invention to provide an improved mechanism by which the molten metal is directly, automatically and continuously transformed into rolled wire without any limits of length as far as molten metal is available. The mechanism is such that the metal, previously brought to the liquid state, is fed to the improved casting machine of the invention wherein a solid bar is produced continuously which may then be directly transformed into rolled wire by passing through a special train of aligned rolling means. One embodiment of the invention is represented in the accompanying drawings merely by way of example not limiting the scope of the invention.

Fig. 1 represents the machine for producing the solid bar having triangular cross-section. Such a cross-section offers considerable advantages, as compared with the other possible shapes, in forming and extruding the cast bar.

Fig. 2 is a cross-sectional view of one of the components of the machine of Fig. 1.

Figures 3 to 7 show a form of a train of special rolling mills aligned for the rolling of the continuous bar.

Figs. 8 and 9 represent an embodiment of the complete production process with the smelting and automatic pumping furnace to feed the molten metal to the casting machine, which in turn feeds the material to the rolling mill train.

With reference to Fig. 1, the transformation of the molten metal into a continuous solid bar is obtained by means of a rotating drum **1** on the peripheral surface **3** of which there is provided a groove **2**, closed by the metal belt **4** along the arc along which the said belt **4** engages the peripheral face **3** of the rotating drum **1**. The belt **4**, like a common transmission belt engages also the wheel **5**, which is freely rotatable about the pin **6**, the latter being supported by the arm **7**. The arm **7** is rotatably mounted on the pin **8** in such a manner as to ensure tension of the belt **4** even if by the action of heating the said belt **4** grows in length. To the rotatable drum **1** there is imparted a slow rotation in the sense of the arrow by means of the motor **9**, which by means of the pulleys **10** and **11** and of the

belt **12** actuates the speed reduction gear **13**, which, by means of the pinions **14** and **15** and the chain **16**, imparts to the rotatable drum **1** a suitable speed of rotation.

The upper portion of the peripheral surface **3** of the drum **1** does not contact the belt **4**, where there is placed a container **18**, supported by the support **17**. Container **18** contains at about constant level the molten metal **19**, which, by means of the nozzle **20**, flows into the cavity **21** formed by the groove **2** and the belt **4**, see Fig. 2.

The container **18** is kept at a suitable temperature by means of, for example, electric resistors **22** arranged in refractory casings. The liquid metal coming from the bottom of the container **18** and, therefore, free from oxides and slag, flows into the nozzle **20** from which it comes out as a liquid stream **24**, the latter being transformed into a solid bar **25** in the cavity that is continuously formed by the groove **2** and the belt **4**. This transformation takes place without vortical movements or dripping as would cause oxide films to be included inside the bar. It is, therefore, of utmost importance that solidification takes place immediately close to the mouthpiece (outflow) and in a zone where the groove **2** of the drum has only slight inclination, so that the liquid stream **24** may swell to fill the groove confined by the belt, without any whirls, which would prejudice the formation of the cast bar. This is an essential feature to obtain continuous cast bars of reduced dimensions but of faultless structure. This zone of formation resulted to be defined by the circular sector of the periphery **3** of the drum **1** comprised between 15 and 45° from the vertical, in the sense of motion.

It has further been found that it is necessary to reduce to a minimum the path of solidification, that is to say the length confined between the cross-section of the bar not yet completely solidified and the one completely liquid. This path constitutes the piece of bar in course of formation, in which the linear shrinkage of solidification may produce considerable cracks. To this end, the drum **1** is subjected to vigorous cooling by means of water circulating inside the peripheral ring. Circulating water enters at the hub **26** of the drum **1** and circulates through the hollow spokes **27** and **28** and to the conduit **29** provided in the rim of the drum **1**, wherefrom it returns to the hub through the hollow spokes **30** and **31**, to discharge as indicated by the arrow in Fig. 2.

In Fig. 1 can be seen the solid bar **32** of approximately triangular shape coming out in a continuous way from the drum **1** at the point where engagement of the belt **4** terminates, to enter the rolling mill. At **33** there is shown a wedge-shaped slide pressed against the groove **2** and compelling the bar to leave the cavity where it formed. **34** shows the base of the machine and **35** a conduit which supplies the molten metal to the container **18**.

The rolling mill train shown in Figures 3 to 7 is composed of any number of rolling mill units each of which is composed of three rolls converging at 120° in a central rolling axis where the shape of the said rolls determines the rolling area. Fig. 3 shows one of these rolling mills whose rolls **36**, **37** and **38** are fitted onto shafts **39**, **40** and **41**. The shaft **39** is driven from shaft **46** through gearing couple **47** and **48**, and shaft **46** is driven from the main driving shaft **42** through pulleys **43**, **44** and belt **45**. Shaft **39** transmits rotation to the shafts **40** and **41** by means of the conical couples **49**, **50** and **51**, **52**. Rotation of the driving shaft **42** renders it possible for a metal bar, for example having circular cross-section, to be rolled in the mill according to the curvilinear and equilateral triangle-shape as shown in Fig. 4.

Fig. 5 shows the subsequent rolling mill unit of the rolling mill train, which unit engages the bar emerging from the unit shown in Fig. 3, and the bar is reduced again to circular cross-section as in Fig. 6. In the rolling mill of Fig. 5 the rolls **53**, **54** and **55** rotate in planes shifted by 60° with respect to those of the rolling mill of Fig. 3. These rolls **53**, **54** and **55** are profiled at their periphery as arcs of a circumference so as to create a circular passage in which the bar coming from the mill of Fig. 3 is engaged and conveniently guided, the said bar being of approximately triangular cross-section. As can be seen in Fig. 6, the edges of the triangular bar coming from the rolling mill of Fig. 3 (bar having roll shaping as shown in Fig. 4) are rolled by the central portion of the rolls of the mill represented in Fig. 5, which rolls are shaped as arcs of a circle as in Fig. 6. Notable reductions are thus obtained with concentric rolling operations, which cause less transversal creeps in the inner cross-sections of the bar in course of plastic transformation. In comparing Figures 3 and 5 with each other it can be clearly seen how the rolls of each rolling mill rotate in planes shifted by 60° with respect to those of the preceding as well as of the subsequent mills. This arrangement is designed to prevent transversal torsions in the bar, which torsions would inevitably occur when rolling in a continuous train with closely positioned passages as in the case of the invention. Fig. 7 shows how a set of such couples of rolling mills (Figures 3 and 5) may be aligned and controlled by one single shaft **59** in order to obtain rolled metal wire with only one operation of multiple passages, taking care to choose speed of rotation of the rolling mill units in proportions increasing in accordance with the elongations of the bar. In Fig. 7 there is shown a rolling mill **56** such as the one of Fig. 3, while **57** is a rolling mill such as the one of Fig. 5 and **58** again one as in Fig. 3 and so on. **59** is the driving shaft, which actuates all the rolling mills of the train through suitable ratios of speed, of course also respecting the right sense of the rolls. Now the induction furnace will be described, which by means of electromagnetic pumping supplies the machine with continuous casting molten metal. In Fig. 8, there can be seen at **60** a low frequency induction furnace for the smelting of metals, of the twin winding type, wherein the melting channels **61**, **62** and **63** of the metal produce at the centre **64** electromagnetic pressures known under the name of pinch effect or Northrup pressures, which pressures occur in the molten metal under the action of the electro-magnetic forces produced by the strong electric currents passing through the conducting molten metal in the channels **61**, **62**, **63** having restricted cross-sections.

These currents inside the molten metal, which occur in any induction furnace, can be utilized in the secondary channel **62** at the point **64**, where the flow of the molten metal is upwards. Here there is inserted the refractory pipe **65** along which the liquid metal is forwarded, and made to run into the constant level container **18**. This pipe **65** is suitably heated in the portion over the molten metal level, by means of the resistor **66**, in order to prevent solidification of the metal. This induction furnace is capable of melting the metal at any temperature and of conveying it automatically to the casting machine. As in the case of the container **18**, from which the liquid metal is taken at the bottom, also here the liquid metal comes from the bottom of the furnace and is, therefore, free from slag and oxides. Fig. 9 shows another vertical section of the furnace of a type having immersed resistors, which are well known. Fig. 8 shows clearly how the molten metal of the induction furnace **60** is automatically pumped by the pinch effect along the pipe **65** that feeds it to the container **18**, from which it passes onto the drum **1**, where it is transformed into a solid bar **32** having triangular cross-section. Bar **32** passes through the guide **67** into the rolling mill **68** wherein it is transformed into round cross-section. This round bar becomes triangular again in passing through the rolling mill **69** wherefrom it passes through the guide **70** to engage the rolling mill **71** wherefrom it comes out with a round cross-section and so on, as there may be provided any number of such rolling mills. At **72** there can be seen the rolled wire emerging continuously, automatically and directly from the liquid metal. At **73** there is shown a heating device, which may be electric for example, to heat the solid bar **32**, which in some cases must be brought to suitable temperature before being subjected to plastic transformation.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. In apparatus for the casting of molten metal into a continuous solidified bar relatively small in cross-section and adapted to be fed directly into a rolling machine for rolling the bar into redraw rod and the like, with the apparatus handling the molten metal fed into the machine in a manner so as to provide the cast bar substantially without faults in internal texture and on the surface thereof, and with said apparatus including a molten metal carrying receptacle having an extending spout with a mouthpiece at the end thereof for feeding the molten metal into the apparatus, the combination in such apparatus for providing the described casting including a casting drum mounted for rotation and having a continuous open casting groove in a peripheral part thereof, a wheel rotatably mounted and spaced away from said casting drum, an endless band looped over the casting drum and the wheel with its inner surface contacting said peripheral part on each side of said casting groove to cover said casting groove and provide a moving casting mold over an arc of travel of substantially 180°, with the endless band around said wheel and said casting drum defining an enclosed area within the outline thereof in which said casting drum and said wheel are mounted, means for respectively supporting said wheel and said casting drum on a pair of parallel axes with said wheel in a position diagonally above said casting drum so that said endless band looped over the same forms a line of juncture with the peripheral part of the casting drum to provide a molten metal receiving opening into the moving casting mold at said line of juncture with the molten metal carrying receptacle spout mouthpiece adjacent thereto, and with the casting mold acting to contain the molten metal at a level adjacent the mouthpiece of the extending spout, with said metal receiving opening being at a position in the path of travel of the casting mold so that the molten metal level lies within the sector spaced from the vertical in the direction of travel of the casting drum and which such sector includes an arc on the peripheral part of the casting drum defined by two points at substantially 15° and substantially 45° from the vertical, such molten metal flowing into the casting mold from the mouthpiece of the spout without a disturbing movement therein before bar solidification such as to cause faults in the solidified cast bar, said casting drum having a coolant accommodating cavity therein for receiving a coolant adjacent the metal receiving opening in the casting mold to remove heat from the casting drum and cool and solidify the molten metal into a solid continuous uniform cross-section bar, means for introducing a coolant into said cavity, such continuous bar issuing from said casting mold and being in a condition to be fed directly into a rolling machine.

2. In apparatus for the casting of a continuous metal bar of relatively small cross-section which is adapted to be fed directly from the casting apparatus into a rolling mill to roll the bar into redraw rod or the like and which is cast substantially without faults such as would interrupt the continuous casting and rolling operation, with such apparatus having a molten-metal-carrying receptacle with a radially extending spout terminating in a mouthpiece at the outer end thereof, the combination in said

apparatus including a rotatable casting drum having a continuous open casting groove in a peripheral part thereof, means providing a horizontal axis mounting said drum, a rotatable wheel spaced from said casting drum, an endless band looped over said casting drum and said wheel and having its inner surface contacting the peripheral part of the casting drum on each side of said casting groove to cover said casting groove over an arc of travel of substantially 180° and provide a moving casting mold while said groove is covered by said endless band, said band defining an area within which said casting drum and said wheel are mounted, axis means rotatably supporting said wheel in a position above said casting drum, with the axes for said wheel and said drum being parallel but spaced apart and with said wheel axis diagonally positioning the same above said casting drum so that said endless band forms a line of juncture with the peripheral part of the casting drum to provide a molten metal receiving opening into the moving casting mold at said line of juncture with the molten-metal-carrying-receptacle spout mouthpiece being adjacent thereto, and with the casting mold acting to contain the molten metal fed thereto at a level adjacent the spout mouthpiece, with said band and casting drum line of juncture being at a position such that the molten metal receiving opening lies within the first arcuate portion of the circle in the direction of movement of said casting drum, and such molten metal level lies within the sector spaced from the vertical point in such first arcuate portion defined by two points at substantially 15° and substantially 45° from such vertical point, the molten metal flowing into the casting mold with such metal receiving opening at such position in a manner so as not to create turbulence in the molten metal before solidifying as would cause faults in the cast bar after solidification, and means for directing a coolant at a peripheral portion of the casting drum from a point substantially adjacent the metal receiving opening to solidify the molten metal in the casting drum adjacent the metal receiving opening, with the solid bar issuing in a continuous member of relatively small cross-section from the casting drum and adapted to be fed directly into a rolling mill.

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