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3,295,173

CASTING MACHINE FOR CLAD METAL BARS

Filed March 23, 1964

3 Sheets-Sheet 1

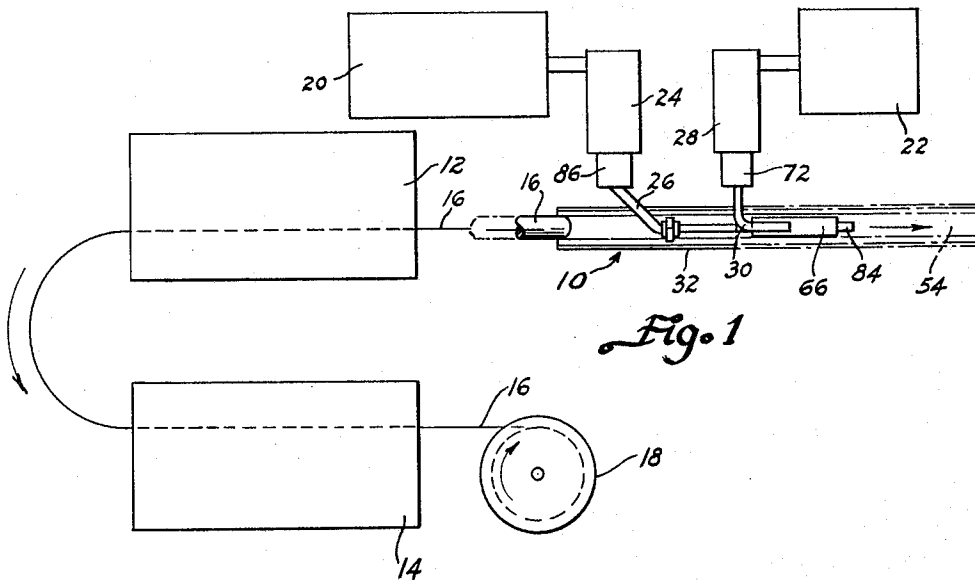


Fig. 1

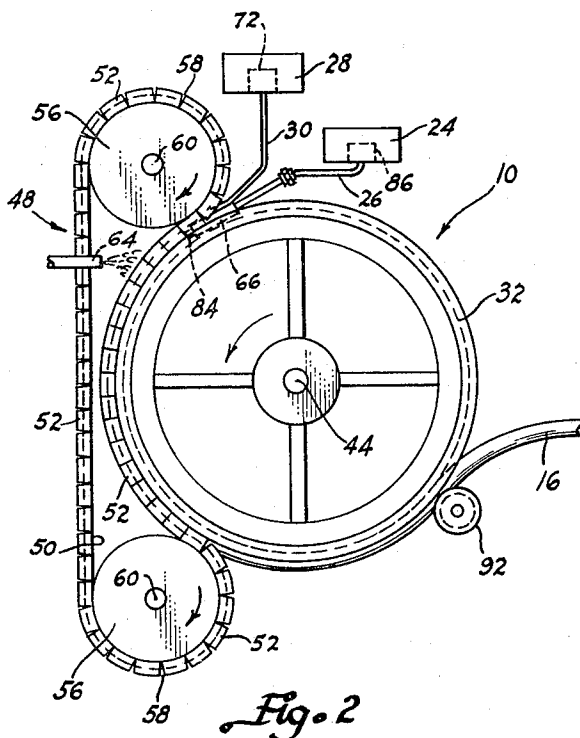


Fig. 2

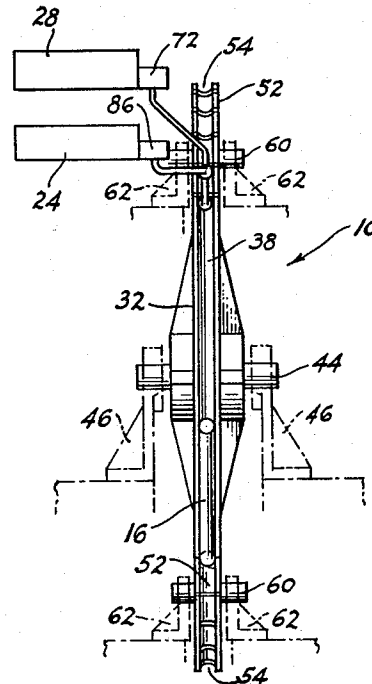


Fig. 3

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3 Sheets-Sheet 2

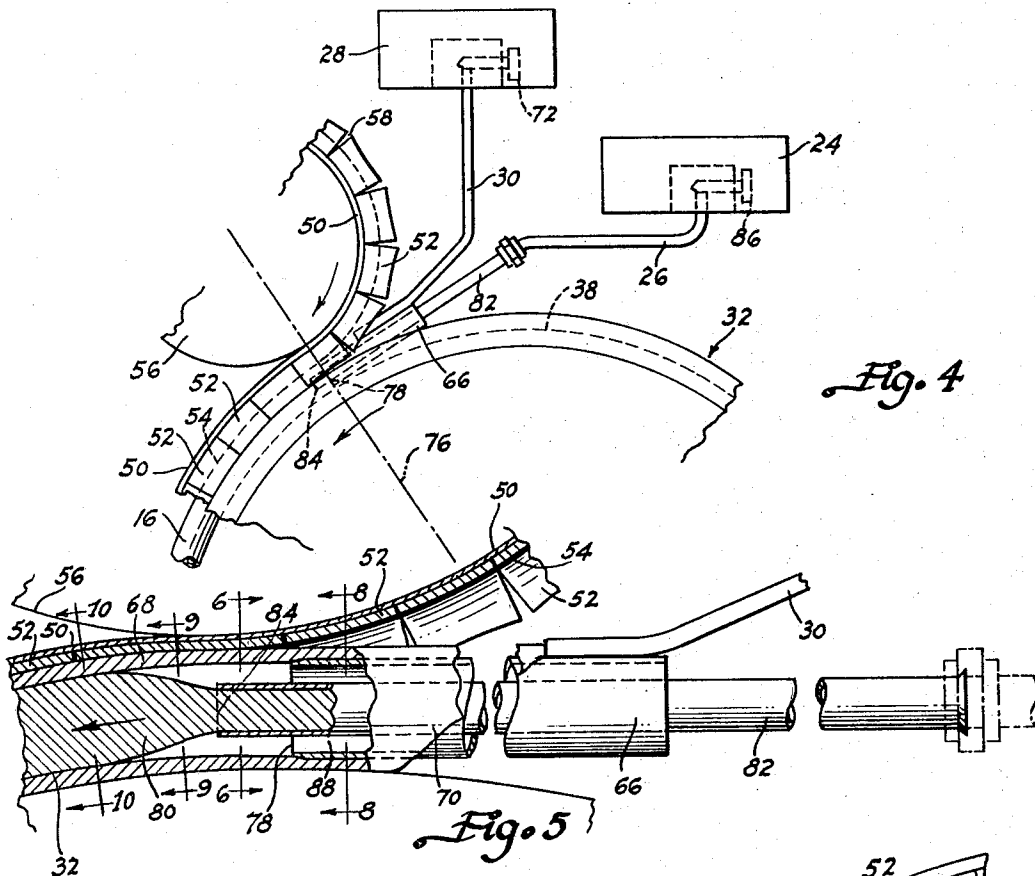
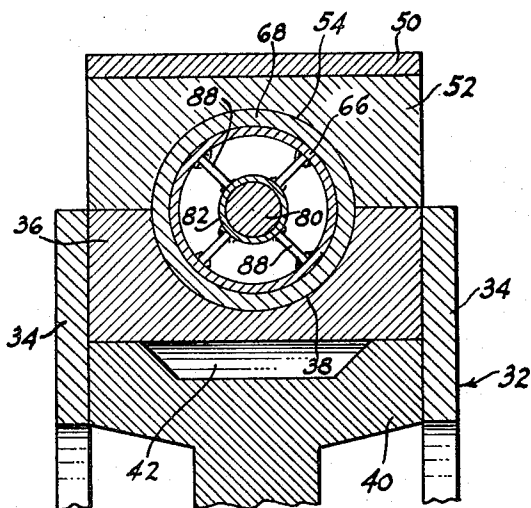
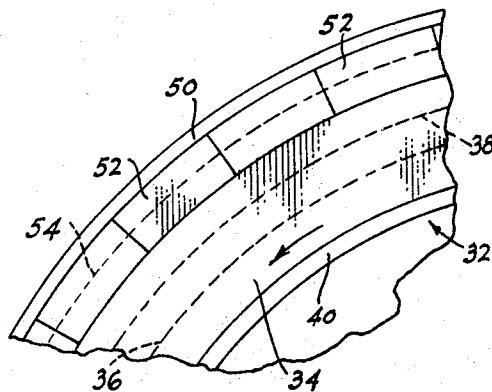


Fig. 7

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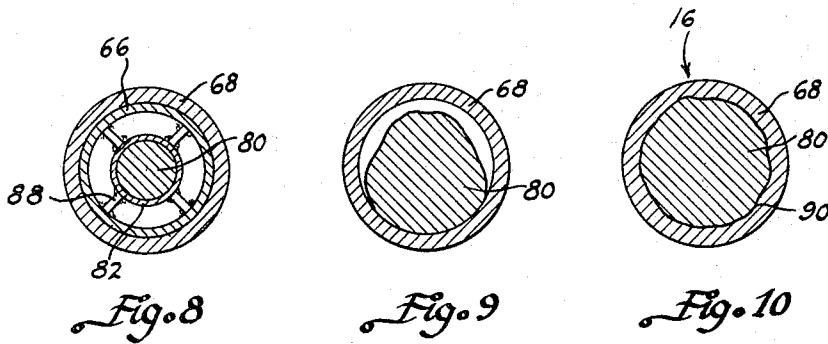
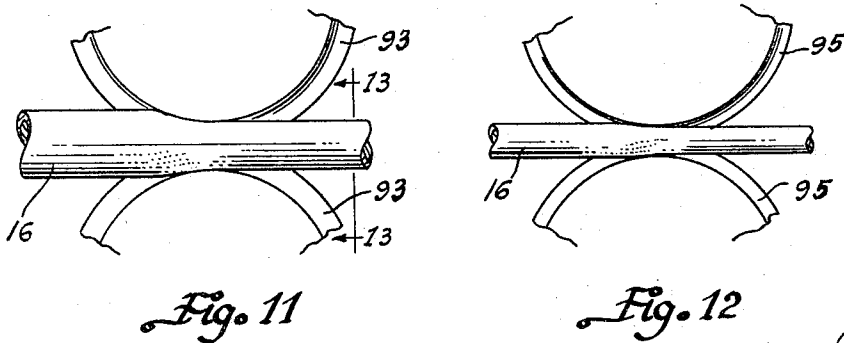
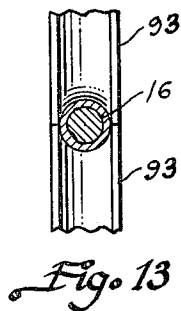
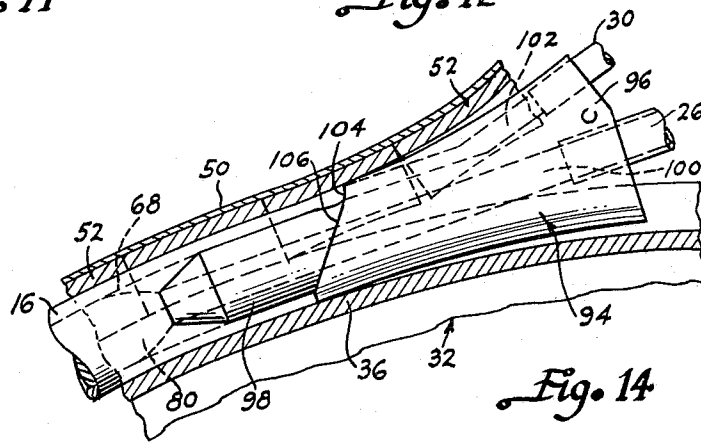
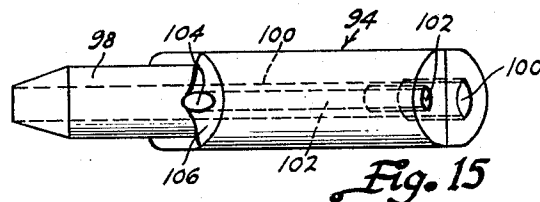
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3 Sheets-Sheet 3



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CASTING MACHINE FOR CLAD METAL BARS

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Filed Mar. 23, 1964, Ser. No. 353,694
7 Claims. (Cl. 22—57.4)

This invention pertains to a machine for casting metallic bar stock comprising a core of one kind of metal, clad with a sheath, extending entirely around the perimeter of the core, of another metallic composition different from that of the core and integrally united therewith. The invention also comprises a process of producing a clad metallic product of such type and, more particularly, for producing a non-ferrous type of clad metallic product in lengths of desired size and, if desired, in continuous lengths.

Many difficulties have been presented heretofore in regard to making raw material in bars of desired lengths, and especially continuous lengths, suitable for being drawn into bars of smaller diameter or wire of various sizes, particularly when it is desired to have the rod or wire product clad with a metallic composition different from that of the core material. Various means have been resorted to to produce products of this type, including the plating of suitable cladding upon a core of desired metallic composition. Cores of desired size also have been dipped in metallic coating material in molten condition. Such procedures require an extra process, however, and such procedures not infrequently present problems relative to the desired firm uniting of the cladding composition to the core material.

Attempts to solve the problems confronting this type of production of clad metallic rod or wire products, and especially those in continuous lengths, have included mechanisms and processes for forming core material of suitable cross-sectional shapes and sizes, followed by the application of a cladding coating to said core by feeding molten cladding material to said preformed core, followed by prompt chilling of the cladding layer. This procedure, however, frequently has not resulted in suitable firm union being made between the core and cladding layer applied thereto.

It is the principal object of the present invention to provide both a machine and a process for forming, simultaneously, from molten metal, a rod or bar-type metallic core clad with metallic material of suitable composition which is applied, in molten condition, to said core before the co-engaging surfaces of either the enclosing cladding material and core have become frozen, thereby to effect firm union without undue intermixing of the core and cladding materials at the interface therebetween.

Another object of the invention is to provide a machine and process by which the cladding material is first formed into a tube-like configuration, continuously for the desired length, said tube-like cladding configuration of suitable metallic composition being subjected to limited chilling to commence to induce shape stability while molten core-forming material of desired composition is fed to the interior of said tube-like cladding member at a rate adequate to fill the interior of the latter and cause firm uniting therewith without undue intermixing at the interface therebetween.

A further object of the invention ancillary to the immediately foregoing object is to induce shape stability in the tube-like cladding element by the application of cooling or chilling means to the exterior of the cladding element while the same is being filled with molten core-forming metal, the chilling being controlled so as not to cause freezing of the inner surface of the cladding sheath

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before the molten core-forming metal has had an opportunity to physically unite therewith, but without undue or unacceptable intermixing at the interface between the core and cladding sheath.

A still further object of the invention is to provide a process by which continuous lengths of composite clad core metallic product may be formed through the expedient of continuously forming an only partially stabilized tube-like sheath or cladding element and filling it with molten core-forming metal, as distinguished from applying cladding metal to a pre-formed metallic core element, said process being achieved by several embodiments of machines or mechanisms each having means for forming tube-like cladding elements of continuous length of the type described and means for introducing molten core-forming metal to the interior of said cladding element, said embodiments of machines also including means adapted to form the exterior of the clad, composite product so as to be of reasonably uniform size in diameter throughout the length thereof and chill at least the outer portions of said composite product sufficiently while maintaining such size thereof so that when the product is discharged from the machine, the shape and composition of the product will be maintained until further reduced by subsequent procedures, such as drawing the same, or the like.

Ancillary to the foregoing object, it is a further object of the invention to provide one embodiment of mechanism in the casting machine comprising a pair of concentric tubular members of different diameters, the larger diameter member being arranged to have molten cladding material flowed therearound and stabilized sufficiently to move longitudinally from the discharge end of said tubular member to form the interior of hollow, tube-like cladding means into which molten core-forming metal is flowed from the smaller diameter tubular means of said mechanism.

Another embodiment of mechanism different from that described immediately above for forming the composite clad core product comprises a substantially solid member having one end formed to have molten clad material flowed therearound so as continuously to form a partially stabilized tube-like cladding means, while a concentric bore in said member delivers molten core-forming metal to the interior of the cladding means, as formed, to effect integral union with the inner surface of said cladding means.

Also ancillary to the foregoing objects of the invention is another object to provide means in the various embodiments of molding machines and mechanisms by which the stream of core-forming metal is of a smaller diameter than the interior of the cladding means which is continuously formed by the machine and into which the core-forming metal is flowed while molten, whereby the linear speed of the stream of molten core-forming metal must be greater than the speed of travel of the cladding means as it is formed by said machine so as to fill the interior of the cladding means, such greater speed of the core-forming metal incidentally insuring movement of the same at a speed which will prevent any undesirable chilling or freezing of the molten metal as it flows to the interior of said cladding means.

Still another object of the invention is to provide a relatively simple metal casting machine preferably comprising a circular wheel-like molding member having a groove in the periphery thereof which is, preferably, semi-circular in cross-section, and additional molding means also having complementary grooves therein which cooperate with the groove of the movable molding member to provide a passage which is substantially circular in cross-section and into which the clad core composite

metallic member passes for final shaping and chilling of the product to render it capable of being handled for further purposes including the rolling and drawing thereof to reduce the diameter to any desired smaller sizes.

A still further object of the invention ancillary to the immediately foregoing object is to compose such additional molding means from a series of flexibly connected blocks shaped to closely abut each other in end-to-end arrangement while conforming closely to the periphery of the circular movable molding member for a substantial segment thereof adequate to effect desired chilling of the product while disposed therein.

Details of the foregoing objects and of the invention, as well as other objects thereof, are set forth in the following specification and illustrated in the accompanying drawings comprising a part thereof.

In the drawings:

FIG. 1 is a diagrammatic plan view of a typical production layout embodying a casting machine employing the principles of the invention and illustrating, on a smaller scale, exemplary rolling mill means arranged in series to reduce the size of the product of the casting machine.

FIG. 2 is a side view showing details of one exemplary embodiment of casting mechanism of the type included in the exemplary layout of FIG. 1 in which the mechanism is seen from the top side.

FIG. 3 is an end view of the casting mechanism shown in FIG. 2, as seen from the right-hand side thereof.

FIG. 4 is a fragmentary side elevation of the upper portion of the casting mechanism shown in FIG. 2, on a larger scale than employed in FIG. 2, to illustrate relative positions of certain elements of the mechanism.

FIG. 5 is a fragmentary side elevational view of the central portion of the mechanism shown in FIG. 4, on a still larger scale than used in FIG. 4, and partly in vertical section to illustrate certain details of the mechanism.

FIG. 6 is a fragmentary vertical sectional view of a portion of the casting mechanism as seen on the line 6—6 of FIG. 5 and on a larger scale than used in FIG. 5.

FIG. 7 is a fragmentary side elevation, on a scale similar to that of FIG. 5, illustrating certain details of the movable molding means of the casting mechanism.

FIGS. 8, 9 and 10 respectively are successive transverse sectional views illustrating various steps in the formation of the composite clad product formed by the mechanism illustrated in the preceding figures, as seen respectively on the lines 8—8, 9—9, and 10—10 of FIG. 5.

FIGS. 11 and 12 respectively are fragmentary exemplary side elevations illustrating representative pairs of reduction rollers of the type employed in the exemplary rolling mills of FIG. 1, FIG. 11 representing one of the early pairs of reduction rollers, while FIG. 12 represents one of the final sets of reduction rollers.

FIG. 13 is an exemplary transverse sectional view as seen on the line 13—13 of FIG. 11.

FIG. 14 is an exemplary side elevation, partly in vertical section, of another embodiment of stationary shaping means and flow means used to form the composite clad product produced by the machine illustrated in the preceding figures.

FIG. 15 is a top plan view of the stationary shaping means and flow means per se shown in FIG. 14.

An exemplary mill layout is illustrated in FIG. 1 to show one typical embodiment of production facilities feasible to produce clad metallic rod-like products, either in continuous lengths, or shorter, desired lengths, in accordance with the principles of the present invention. It is to be understood that the layout is merely illustrative, however, and is not restrictive. In said figure, a casting machine 10 is shown which is capable of producing either continuous or shorter lengths of clad product and which

incorporates the present invention disposed in one suitable arrangement. Other arrangements are possible.

The clad product produced by the machine 10 is led directly to a first rolling mill 12 which is illustrated on a substantially smaller scale than that employed in showing the casting machine 10, for purposes of conserving space. The drawing mill 12 may comprise a series of sets of reduction rollers, for example, each arranged successively to reduce the continuous clad product to smaller diameter. Such product then may be suitably guided into the entrance or left-hand end of a second rolling mill 14 which, like rolling mill 12, preferably includes another series of sets of reducing rollers or other reducing means successively arranged to reduce the continuously formed clad product to smaller diameters until the product 16, for example, may be coiled or spooled at 18 so that the same may be handled conveniently. Flying shears or other means, not shown, may be employed to sever the product when the spool 18 is filled and a new spool quickly is moved into place to receive the continuing discharge of product 16.

The several rolling mills 12 and 14 shown in FIG. 1 merely are illustrated to provide at least an approximate concept of a typical type of production layout within which the casting machine 10, embodying the principles of the present invention, may be used. While not restricted thereto, the machine 10 especially is adapted to form a composite product comprising a core which is integrally connected to an encircling cladding layer or sheath, the core and cladding layer preferably being of non-ferrous nature. By way of further specific example, the machine 10 especially is adapted for the production of clad aluminum wire and particularly such wire of the type employed in the weaving of insect screening or cloth.

Further without restriction thereto, one type of aluminum clad wire suitable for weaving into insect cloth is that wherein the core is formed from aluminum alloy having substantial tensile strength and being of a relatively hard nature compared with the cladding material which preferably is of a different composition of softer aluminum capable of protecting the core from oxidation more suitably than such core material alone. Notwithstanding this specific illustration, however, it is to be understood that the casting machine 10 which embodies the principles of the present invention is adapted for the formation of other types of clad, preferably non-ferrous products in either continuous or shorter lengths.

In FIG. 1, a furnace or cupola 20 is provided in which appropriate raw material, such as pigs of desired metallic composition are fed for reduction to molten condition. The furnace 20 is of commercial type and thus is only diagrammatically illustrated, as is a second furnace or cupola 22 in which suitable raw material of appropriate metallic composition, different from that melted in furnace 20, also is reduced to molten condition. By way of specific example, the furnace 20 is intended to melt core material, while furnace 22 is intended to melt cladding material. In accordance with the preferred operation of the entire mill system, molten material is withdrawn from the furnaces 20 and 22, for a desired period or continuously, while raw material is continuously added thereto to be melted, thus insuring continuous production for substantial periods of time, if desired.

Molten core material is withdrawn from furnace 20 into a suitable transfer pot 24, which feeds molten core-forming material into delivery tube 26. Similarly, furnace 22 in which the cladding material is melted, discharges a continuous stream of cladding material into transfer pot 28 for discharge into delivery tube 30. The transfer pots 24 and 28 primarily are used for purposes of controlling the flow of molten material respectively to the delivery tubes 26 and 30 and in order to accomplish this, the transfer pots preferably are mounted on suitable pivotal supports to permit limited tilting of the

same and thereby control the flow of molten material very readily to the delivery tubes 26 and 30. Other equivalent types of feeding and delivery mechanism may be used, however.

The molding mechanism which receives the molten metal from delivery tubes 26 and 30 now will be described. There are 2 principal cooperating portions of such molding mechanism. One of these comprises, in accordance with the preferred construction of the invention, a circular movable molding member 32 resembling a wheel, for example. The details of preferred construction of said molding member 32 are best shown in FIG. 6 wherein it will be seen that exemplary side members 34, of circular configuration, may be employed to support therebetween a circular rim 36 formed preferably from material having a high coefficient of thermal conductivity, such as copper or the like. The periphery of the circular rim member 36 is provided with a preferably semi-cylindrical groove 38 but it is to be understood that the shape of the groove 38 may be conformed to whatever shape is desired for the exterior of the product to be molded by the member 32.

Also mounted directly in contact with the inner periphery of the circular ring 36 is a complementary circular member 40 having an annular channel 42 therein for purposes of circulating cooling fluid of either gaseous or liquid nature which is supplied to said channel by any suitable means of conventional nature in order that a cooling effect may be imparted continuously to the circular rim 36 of the mold member 32 in order that appropriate chilling may be imparted to the semi-cylindrical groove 38 for purposes to be described.

The mold member 32 is supported for rotation about a suitable transverse axle shaft 44 which is journaled in appropriate bearing members 46 shown in FIG. 3. Any suitable drive means, not shown, may be connected to the shaft 44 to rotate the mold member 32 at a desired speed suitable to accomplish the purposes of the mold member 32 as described in greater detail hereinafter.

Cooperating with mold member 32 is additional molding means 48 which, in accordance with the preferred construction of the invention, is of a flexible nature in order that it may conform to and move so as to cooperate with a desired segmental portion of the movable mold member 32 while preferably traveling at the same peripheral speed. The additional molding means 48 may be constructed in one of several different ways, the present illustration comprising a flexible band 50 of suitable spring steel or the like, for example, but it is to be understood that other means such as appropriate chain construction or the like, may be substituted and used in lieu of such flexible band.

Connected to the flexible means 50 of the additional molding means is a series of mold blocks 52 which preferably are formed from material similar to that from which the circular rim is formed, whereby said blocks likewise will be capable of efficient transfer of heat at suitable rates. Each of said blocks is provided with a preferably semi-cylindrical groove 54 which is complementary to the groove 38 of the circular rim 36. The blocks 52 also are in end-abutting relationship as is clearly shown in FIG. 7, when the same are disposed around the perimeter of movable mold member 32 as shown in FIG. 2. In order that the end-abutting series of blocks 52 may conform closely to the perimeter of circular rim 36 of mold member 32, the faces of each of the blocks 52 which coact with rim 36 are slightly concave so as to conform very closely to the convex contour of the perimeter of mold member 32 and especially the circular rim 36. Further, the ends of the blocks 52 are not exactly perpendicular to the longitudinal axis of said blocks, whereby when they are stretched in a straight line and also when they pass around the peripheries of the supporting rolls 56 therefor, V-shaped spaces 58 occur

between said ends but these spaces are closed when the blocks contact the periphery of mold member 22.

It will be seen that the flexible, additional molding means 48 is so positioned by their supporting rolls 56, which revolve about the axes of suitable shafts 60 extending between bearing members 62, that approximately one quarter of the periphery of movable mold member 32 is engaged by the additional molding means 48. Any suitable drive means, not shown, are connected to shafts 60 to advance the molding means 48 preferably at the same speed as the periphery of molding member 32. Further, if desired, suitable chilling means such as an exemplary air blast 64, and/or other equivalent cooling means, may be applied against the additional molding means 48, especially in the vicinity of where the same first comes in contact with the periphery of movable mold member 32, as well as after leaving contact with movable mold member 32.

The direction of movement of the mold members 32 and 48 is indicated by suitable arrows in FIG. 2, as well as in certain of the subsequent figures. It thus will be seen that said mold members, and especially the complementarily grooved portions thereof, converge and come into contact at a point substantially on a line between the centers of shaft 44 and upper shaft 60, while the same separate at a point substantially on the line of centers between the shaft 44 and the lower shaft 60, as viewed in FIG. 2.

There is illustrated in FIGS. 3 and 4, one embodiment of shaping and flow means for the molten core-forming and cladding material. This embodiment comprises a tubular stationary shaping means 66, which may be formed from suitable steel or other appropriate material, said shaping means being of a smaller diameter than that of the complementary and cooperating grooves 38 and 54 of the molding means, the difference in diameters preferably being substantially that of the thickness desired to be imparted to the cladding means 68 which flows between and is formed by the spaced opposing surfaces comprising the exterior of shaping means 66 and complementary grooves 38 and 54 as readily can be visualized best from FIGS. 5 and 6.

The molten cladding metal flows from transfer pot 28, through delivery tube 30, to the upper exterior surface of stationary shaping means 66, as best shown in FIG. 5, so as to flow around said shaping means, down opposite sides thereof and forwardly from the delivery end of tube 30, somewhat following the exemplary line 70 denoting the flowing edge of such cladding material until the streams thereof flowing down opposite sides of tube 66 meet at the bottom, within the molding groove 38 of movable mold member 32.

Flow of the molten cladding material down the delivery tube 30 is controllable through the use of suitable means such as a graphite valve 72 and such flow is so proportioned to the movement of the cooperating molding member 32 and additional molding means 48 that the space between the cooperating grooves 38 and 54 and the exterior of shaping tube 66 will be filled with cladding material 68 of substantially uniform wall thickness as best can be seen in FIG. 6.

As best can be seen along the line of centers 76 shown in FIG. 4 for the upper roll 56 and movable mold member 32, the terminal end 78 of shaping tube 66 is substantially coincident with said line of centers, whereby as soon as the flowing tubular sheath of cladding means 68 is formed as a result of passing from the terminal end 78 of shaping tube 66, the exterior surface thereof is reasonably stabilized by virtue of being immediately subjected to the chilling effect of the circular rim 36 of mold member 32 and the blocks 52 of additional molding means 48.

Especially when the cladding material is of high thermal conductivity, such as an aluminum alloy, for example, such chilling effect imparted to the exterior of the cladding sheath 68 migrates interiorly quite quickly,

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whereby the shape of even the interior of the cladding sheath 68 is reasonably stabilized though not frozen until the sheath has traveled a short distance beyond the end 78 of the shaping tube 66. Accordingly, though the inner surface of the cladding sheath 68 is not fluid as it emerges from the end 78 of the shaping tube 66, it is not frozen and is highly capable of being united integrally with core-forming material 80 which is delivered to the interior of the cladding sheath 68 at a rate to continuously completely fill it.

The core-forming material is delivered from flow means comprising a tube 82, formed from suitable metal or other appropriate material, which preferably is coaxial with and interior of the stationary shaping tube 66, as readily is seen particularly from FIGS. 5 and 6. Preferably, flow means 82 is of smaller diameter than the outer diameter of shaping tube 66, whereby as said molten core-forming material 80 emerges from the terminal end 84 of flow means 82, it spreads out or expands in order to completely fill the interior of the hollow tubular cladding sheath 68 as illustrated in exemplary manner in FIG. 5.

Said molten core-forming material 80 integrally unites with the inner surface of the hollow cladding sheath 68 which, as described above, has not frozen by the time such union takes place, yet the inner surface of such tubular cladding sheath 68 has been stabilized sufficiently that no undue amount of intermixing of the cladding material takes place with the core material at the interfaces thereof. This results from suitable control of the temperature of the respective material, the rate of flow thereof, and the rate of movement of the cooperating molding members 32 and 48.

The flow of the core-forming material 80 is controlled principally by additional valve means such as, for example, a graphite valve 86. The flow of such material is regulated preferably so that the linear speed of the molten core-forming material through the flow means 82 is greater than the peripheral speed of the movable mold member 32. This not only is necessary in order to effect filling of the interior of the hollow cladding sheath 68 with said core-forming material, but, in view of the fact that the inner diameter of flow means 82 is substantially less than that of stationary shaping means 66, there is some danger of the core-forming material freezing within the tubular flow means 82 unless the rate of flow is such as to prevent freezing from occurring. Further, to position the flow means 82 substantially concentrically with the tubular shaping means 66, any suitable means therebetween such as spider ribs or strips 88, or the like, may be employed. The united means 66 and 88 is supported by suitable mechanism such as by the means 66 and 88 respectively being connected to flow means 82 and delivery tube 30.

To graphically illustrate the progress of the formation of the united composite rod-like product comprising core 80 encircled by and united with cladding sheath 68, attention is directed to FIGS. 8, 9 and 10 which respectively show such progressive formation relative to the section lines 8—8, 9—9, and 10—10 of FIG. 5. Particularly with reference to FIG. 10, it will be seen that the interface 90 between the core and sheath of the composite rod-like product 16, though somewhat irregular, generally is circular in cross-section.

Considering the fact that a product of this type is merely the initial phase of the end product which, generally, is many times smaller in diameter than such initial phase, it is understandable that after said rod-like product 16 emerges, in chilled condition, from between guide wheel 92, for example, and movable mold member 32, and is subjected to repeated reductions to reduce the diameter thereof, any irregularities in the interface between the core and sheath of the product 16 will be minimized.

Solely by way of exemplary illustration, FIG. 11 represents, for example, the first pair of reduction rollers 93 of the first mill shown in FIG. 1, and FIG. 12 illustrates the last pair of reduction rollers 95 at the terminal end

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of the second mill shown in FIG. 1, for example. By way of further example, whereas the initial diameter of the composite product 16 emerging from the molding members 32 and 48 may be relatively large, the diameter of the product 16 emerging from the final pair of drawing rolls 95 may be of the order of $\frac{3}{8}$ ", depending entirely upon the number of sets of drawing rolls or other diameter-reducing means embodied in each of the mills. However, when reduction of the exemplary type described above occurs, the product emerging from the second mill, for example, readily may be coiled, reeled or spooled at 18 with no difficulty and thereby adapt the product to ready handling for introduction to further wire drawing means or otherwise.

Referring to FIGS. 14 and 15, another embodiment of shaping means for forming the cladding sheath 68 and flow means for directing the molten core-forming material to fill the cladding sheath 68 is illustrated. Said embodiment comprises a unitary member 94, which is suitably supported by any appropriate stationary means substantially at the convergence of the movable mold member 32 and the flexible additional molding means 48 as best shown in FIG. 14. Member 94 may be formed from any suitable material such as an appropriate ceramic-like substance, or otherwise, readily capable of withstanding the heat of molten metal and especially molten nonferrous metals. In side view, the member 94 somewhat resembles a horn of simple configuration, having an enlarged outer end 96, and a cylindrical inner terminal end 98 having an outer diameter less than the vertical dimension of the intermediate portion of member 94 and preferably substantially equal to the outer diameter of stationary shaping tube 66 of the embodiment shown in the preceding figures.

Combination shaping and flow member 94 is provided with a plurality of longitudinally extending, internal bores respectively receiving molten cladding material and molten core-forming material. Bore 100 extends longitudinally through the entire length of member 94. The discharge end of delivery tube 26 for the core-forming material is connected to the outer end of bore 100 and the opposite end thereof discharges molten core-forming material into the interior of the cladding sheath 68 which is formed by molten cladding material being delivered through bore 102 to which the delivery end of delivery tube 30 is connected. The terminal end 104 of bore 102 opens through a shoulder surface 106 intermediately of the ends of member 94 and defining one end of the cylindrical terminal end portion 98 of member 94.

As best seen from FIG. 14, the shoulder surface 106, in side elevation, slopes forwardly and downwardly so as to direct molten cladding material around all surfaces of the exterior of the terminal end 98 of member 94 and insure the formation of a completely tubular cladding sheath member 68. As in regard to the embodiment illustrated in the preceding figures, as the cladding sheath 68 is formed by emerging from the end of terminal portion 98 of member 94 and chilling thereof commences from the exterior thereof through contact with the grooves 38 and 54 of the molding members, stability of shape is induced in said tubular cladding sheath 68, without freezing of the inner surface thereof until after molten core-forming material 80 has been discharged from the terminal end of bore 100 thereinto for integral union with the inner surface of the tubular cladding sheath 68 without substantial intermixing at the interface. Also as in regard to the preceding embodiment, the rate of flow of the respective materials, temperatures thereof, and speed of the molding members are all controlled with respect to the embodiment shown in FIGS. 14 and 15 so as to produce a composite clad product 16 similar to that produced by said preceding embodiment.

It is to be understood in the foregoing description and the appended claims that while the process and several embodiments of apparatus comprising the present inven-

tion are particularly adapted to produce a rod-like clad product of continuous length, the term "continuous" is to be construed as embracing either bars of relatively limited length as well as bars of many hundreds of feet in length, depending upon the use to which the product is to be put or further processing to which it is to be subjected.

While the invention has been described and illustrated in its several preferred embodiments, it should be understood that the invention is not to be limited to the precise details herein illustrated and described since the same may be carried out in other ways falling within the scope of the invention as claimed.

We claim:

1. A machine for casting continuous lengths of metallic composite rods and the like of uniform cross-section and comprising a core member completely encased in a sheath united integrally therewith, said machine comprising in combination, molding means comprising a plurality of molding members movable at similar speeds and having complementary surfaces movable into engagement with each other to define a longitudinal molding cavity of uniform cross-section from the point of contact and of sufficient length to form and stabilize the exterior surface of said composite rods, tubular shaping means supported stationarily substantially coaxial to and extending longitudinally into said molding cavity and having an exterior surface positioned adjacent the point of contact of said molding members to guide the flow of sheath-forming molten metal into said longitudinal molding cavity for initial contact with said mold means substantially adjacent the point of engagement of said cooperating surfaces of said molding members to form a hollow sheath and shape the exterior surface thereof and cause initial chilling thereof to stabilize the same for reception of molten core-forming metal, whereby molten sheath-forming metal does not contact said molding cavity prior to the point of engagement of said cooperating surfaces of said molding members, flow directing means extending through said shaping means substantially coaxially thereof and operable to direct the flow of molten core-forming metal into said hollow sheath immediately as it is formed and partially stabilized while retaining partial latent heat of fusion, means to deliver molten metal of one composition to said shaping means for passage therearound and into said longitudinal molding cavity to form a hollow sheath member of continuous length and substantially uniform cross-sectional shape, and additional means to deliver molten core-forming metal of a different composition continuously through said flow-directing means and into the hollow interior of said sheath to fill the same and bond therewith while said composite rod progressively moves with said mold member for a predetermined distance sufficient to chill and stabilize the same.

2. The metal casting machine set forth in claim 1 further characterized by one of said movable molding members being substantially circular and mounted for rotation about the axis thereof and having a peripheral molding

groove therein, and additional molding means conforming to and moving with at least a portion of the periphery of said rotary molding member as it rotates to carry therebetween said composite rod of cladding material and core therein while chilling and stabilizing the same, said shaping means being positioned substantially tangentially to the periphery of said circular molding member and sloping downwardly from the horizontal toward said periphery at the delivery end of said shaping means.

3. The metal casting machine set forth in claim 2 further characterized by said shaping means having at least a partially cylindrical exterior surface on the end thereof nearest the periphery of said circular molding member to impart a substantially cylindrical shape to the interior of said sheath of said composite rod to be formed by said machine.

4. The metal casting machine set forth in claim 1 further characterized by said flow-directing means comprising tube-like means within said shaping means.

5. The metal casting machine set forth in claim 1 further characterized by the discharge end of said flow-directing means extending forwardly beyond the exterior surface area of said shaping means which is first engaged by said sheath material, thereby permitting said shaping means and longitudinal molding cavity substantially to form and appreciable stabilize said sheath immediately prior to the core material flowing thereto.

6. The metal casting machine set forth in claim 1 further characterized by said stationary shaping means and flow directing means being a unitary member having a plurality of bores extending longitudinally therein, one end of said member being externally cylindrical and comprising said shaping means and one of said bores opening at its delivery end onto said cylindrical surface to deliver cladding metal thereto, and the other bore discharging core-forming metal from the outer end thereof into the formed hollow sheath of cladding material.

7. The metal casting machine set forth in claim 6 further characterized by said other bore being substantially co-axial with said cylindrical end of said unitary member.

References Cited by the Examiner

UNITED STATES PATENTS

2,128,941	9/1938	Hudson	22—200.1
2,185,429	1/1940	Burby.	
2,206,930	7/1940	Webster	22—57.3
2,763,044	9/1956	Brennan	22—220.1
2,865,067	12/1958	Properzi	22—57.4
3,110,941	11/1963	Fagg	22—57.4
3,200,456	8/1965	Harter et al.	22—200.1

FOREIGN PATENTS

525,756 6/1956 Canada.

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