Feb. 3, 1970 A. C. BOYCE 3,492,697

ROTATIONAL CASTING APPARATUS

Filed May 16, 1968 5 Sheets-Sheet 1

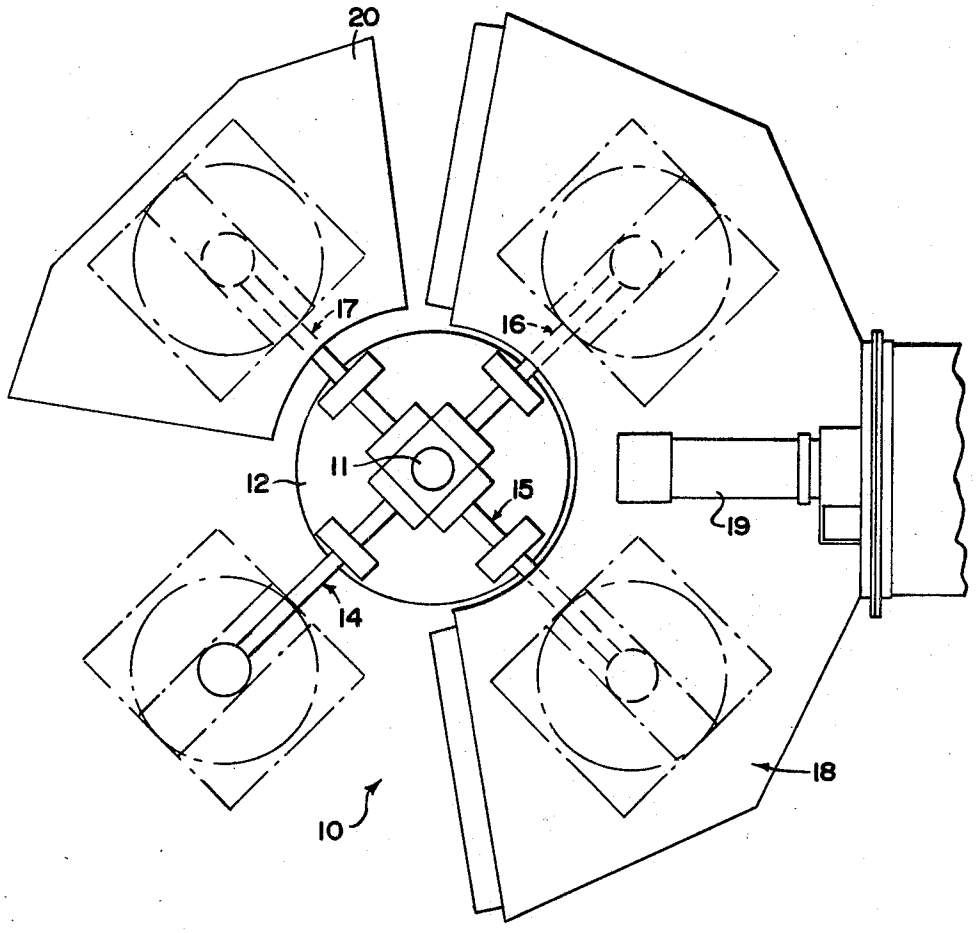

FIG. 1

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5 Sheets-Sheet 2

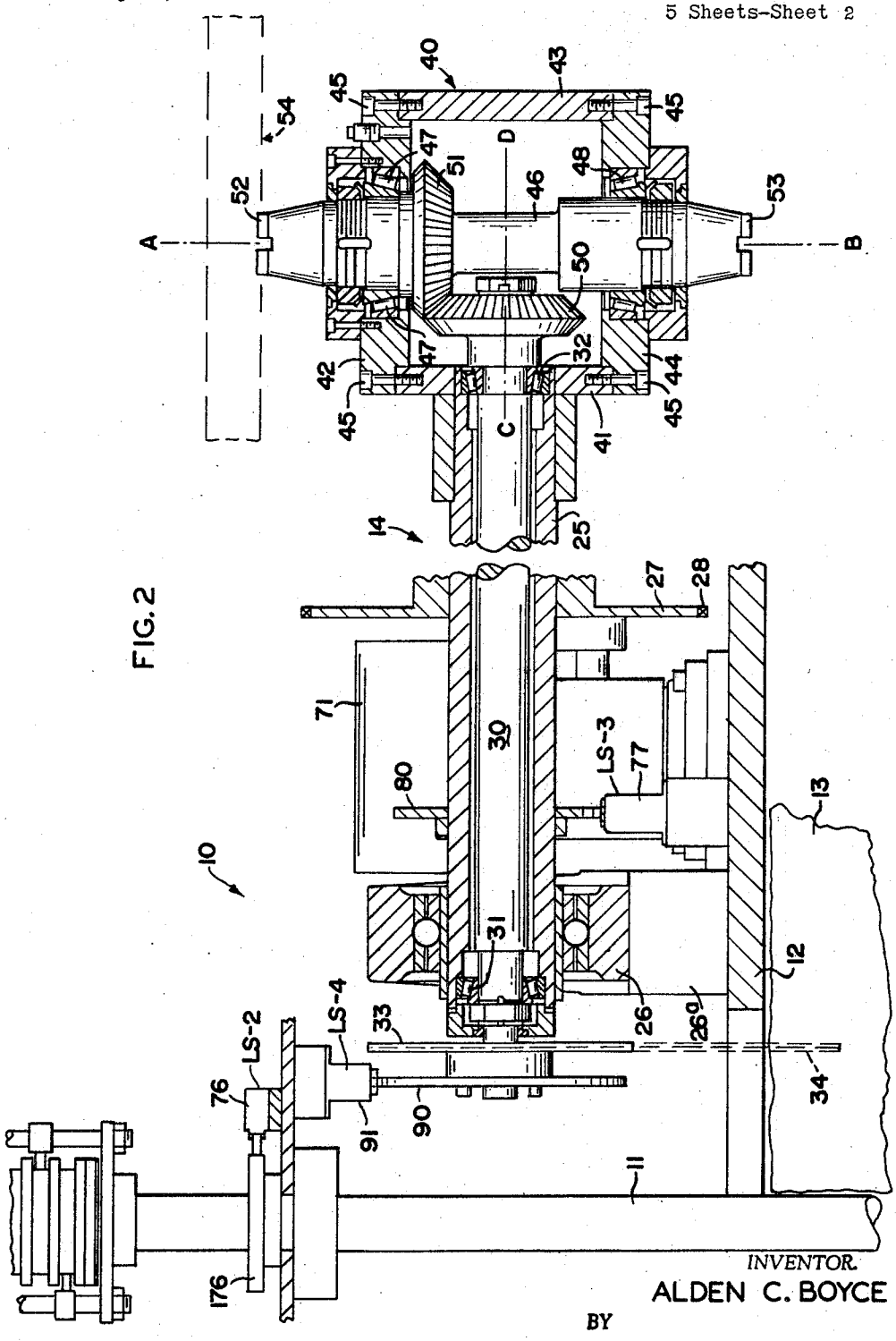

FIG. 2

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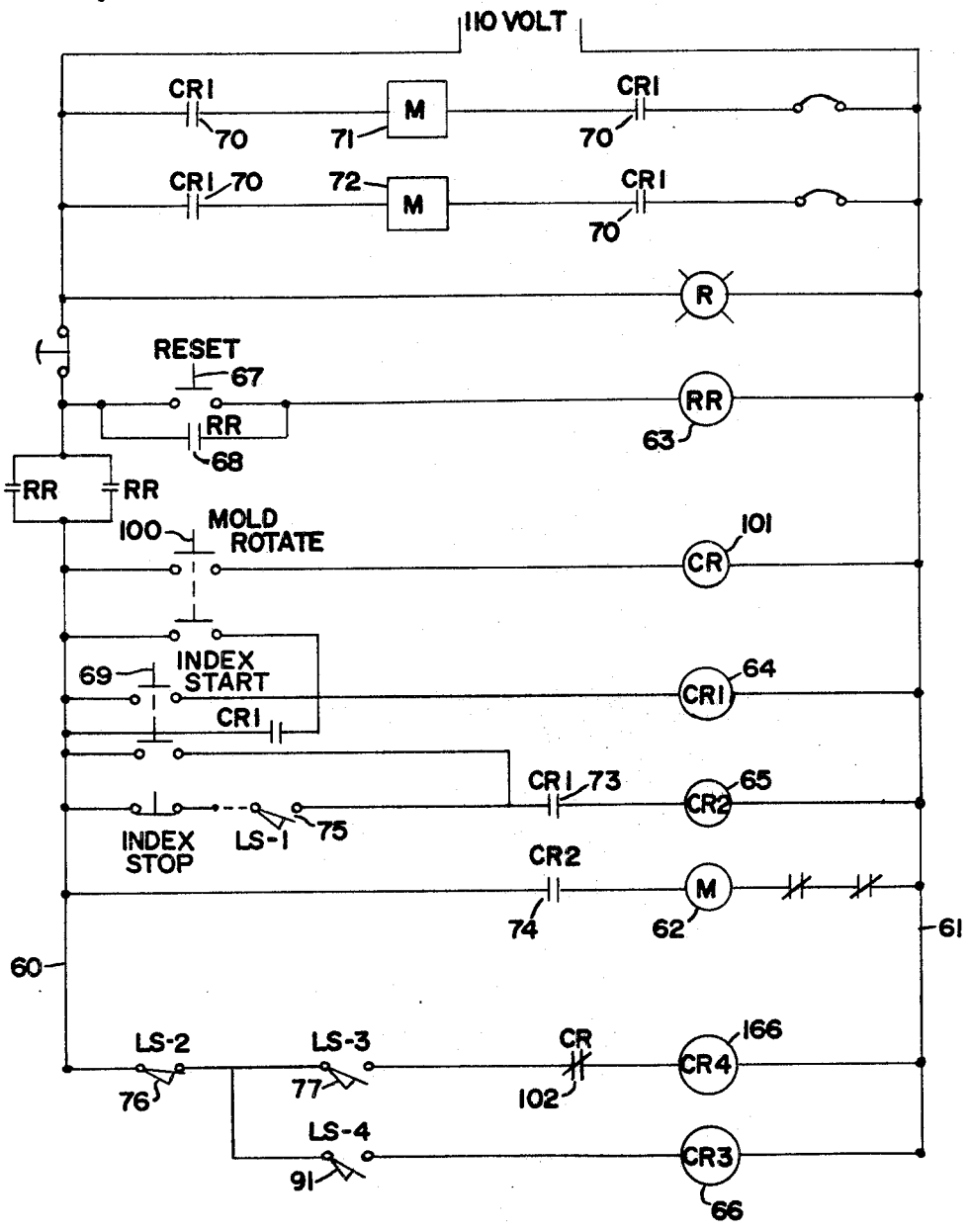

FIG. 3

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ROTATIONAL CASTING APPARATUS

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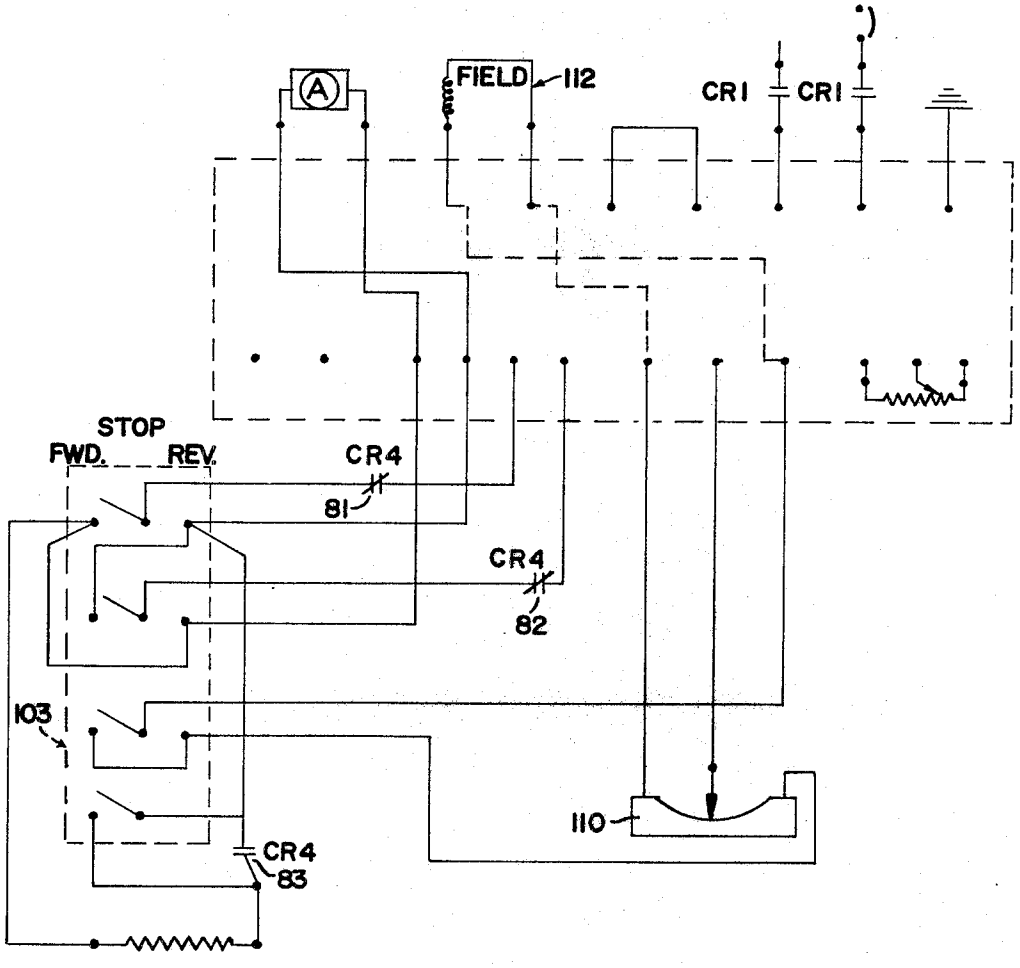

FIG. 4

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ROTATIONAL CASTING APPARATUS

Filed May 16, 1968 5 Sheets-Sheet 5

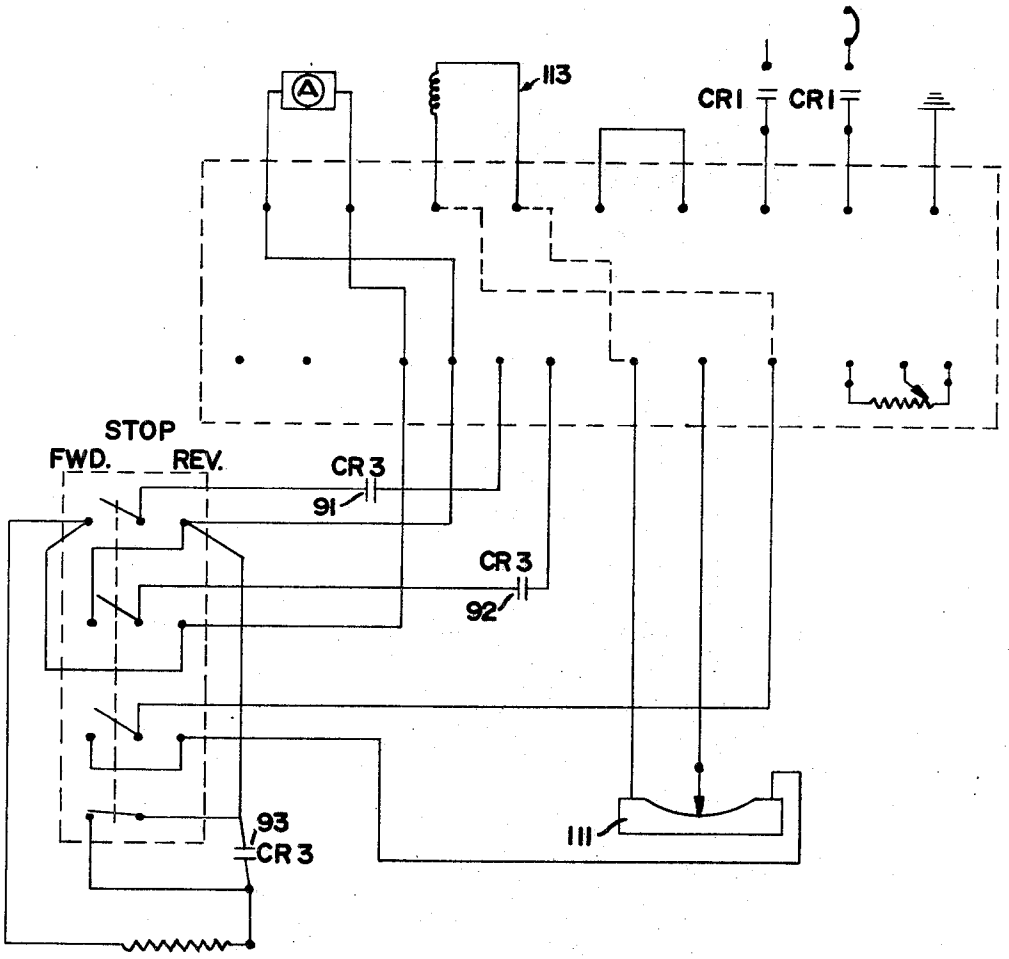

FIG. 5

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United States Patent Office 3,492,697
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ROTATIONAL CASTING APPARATUS

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Int. Cl. B29c 5/04
U.S. Cl. 18—26 7 Claims

ABSTRACT OF THE DISCLOSURE

A rotational casting machine having an inner shaft and an outer sleeve, coaxial with the inner sleeve, are provided with a gear box assembly being operatively secured to the outer sleeve for rotation therewith. A mold carrying spindle is journalled in the gear housing and is positioned on an axis perpendicular to the inner shaft which engages the spindle for rotation thereof on its own longitudinal axis. Cam and switch means are associated with the outer and inner shafts for controlling rotation thereof to stop the outer sleeve with one end of the mold carrying spindle being uppermost whereby molds secured thereto are substantially horizontally positioned for mold opening, article removal and mold filling action. The mold carrying spindle and outer sleeve are provided with controlled rotation through 180° for again positioning molds horizontally for opening, article removal and refilling action.

The present invention relates to rotational casting apparatus wherein a plurality of molds are adapted to be positioned in the apparatus and be rotated simultaneously at controlled speeds on major and minor axes positioned at 90° with relation to each other.

Heretofore, there have been many different types of rotational casting machines provided and certain of these machines have had some appreciable commercial acceptance. However, these machines are relatively expensive, and complex in mechanical construction.

Another problem encountered in most rotational casting machines with which I am familiar is that it is difficult, if not impossible, to stop rotation of the mold carrying shaft with the molds thereon in proper positions for mold opening and article discharge action and in many instances, one mold spindle must be manually rotated for proper mold positioning for recharging the mold and removing articles therefrom.

It is the general object of the present invention to provide a relatively uncomplicated, sturdy type of rotational casting apparatus which is adapted to have a long service life with a minimum of maintenance thereon.

Another object of the invention is to provide special control circuits in rotational casting apparatus whereby the mold carrying spindle in the apparatus can be stopped in a vertical position with one end thereof uppermost to position the molds thereon in substantially horizontal positions, and then to provide substantially 180° rotation of such mold carrying spindle on the major axis of rotation to position the other end of the mold carrying spindle uppermost to present the molds associated therewith in horizontal position for opening, article discharge and mold recharging action.

A further object of the invention is to provide a novel mold positioning spindle in a rotational casting apparatus and to rotate it at any suitable speed in either direction as desired.

Another object of the invention is to provide a relatively uncomplicated rotational casting apparatus with improved controls therefor directly actuated by and controlled by the inner shaft and outer sleeve on which the rotary casting apparatus is positioned so as to control

starting and stopping action on the drives therefor readily and to terminate the outer mold spindle drive in a predetermined manner.

The foregoing and other objects and advantages of the invention will be made more apparent as the specification proceeds.

Reference now is made to the accompanying drawings, wherein:

FIG. 1 is a diagrammatic plan view of apparatus embodying the principles of the invention;

FIG. 2 is an enlarged fragmentary vertical section through one rotary spindle assembly of the invention and associated apparatus of the structure shown in FIG. 1;

FIG. 3 is a diagrammatic view of the wiring diagram for the controls of the invention;

FIG. 4 is a fragmentary diagrammatic view of the wiring details of portions of the motor control circuit for the outer shaft; and

FIG. 5 is a fragmentary diagrammatic view of a portion of the circuit control for rotation of the inner shaft of the apparatus.

When referring to corresponding members shown in the drawings and referred to in the specification, corresponding numerals are used to facilitate comparison therebetween.

With reference to the details of the structure shown in the accompanying drawings, a rotational casting machine of the invention is indicated as a whole by the numeral **10**. This machine **10** includes a support column or post **11** that has a turntable **12** operatively associated therewith. Only a portion of the frame **13** for the machine **10** is shown, and the machine includes a plurality of mold support means, or arm assemblies **14**, **15**, **16** and **17** that are operatively carried by the turntable **12** and normally extend radially therefrom. The machine **10** is shown as having an oven **18** with suitable heat supply means **19** connected thereto operatively associated with the frame **13** to receive a pair of the mold support means therein at all times for heating, curing or setting up the materials carried in the molds in the mold assemblies by heat while the mold carrying means are being rotated in the oven **18**. A cooling station or enclosure **20** also is provided in the machine and one of the mold support means or assemblies is operatively positioned in such cooling chamber for enclosure **20** at all times. Suitable arcuate movement of the turntable **12** is provided whereby it is adapted to be indexed through operative stages of 90° so as to position the mold support means in predetermined arcuate relationships to the frame **13** and support column or post **11**. The mold carrying arm **14** in FIG. 1 is shown at the mold opening and loading station of the apparatus and one such arm is stopped by indexing action at such station at each increment of indexed movement.

In FIG. 2, the details of one typical mold support means **14** are shown and such means includes an outer sleeve **25** which is journalled in a pair of bearings **26**, positioned in radially spaced housings **26***a* carried by the turntable. Only one bearing and housing is shown in the drawings. Such sleeve **25** is hence positioned for rotation on its longitudinal axis which is considered to be the major axis of rotation for the molds carried by the machine **10**, as hereinafter described. This outer sleeve **25** has a conventional drive means, such as a sprocket **27** secured thereto, and a chain or equivalent drive means **28** connects to the sprocket **27** and connects to a drive motor **71** which comprises a D.C. adjustable speed motor for controlled drive of this outer sleeve **25**, as hereinafter described.

An inner shaft **30** is journalled within the outer sleeve **25**, as by bearings **31** and **32** and the ends of the inner

shaft 30 protrude from the outer sleeve at each end thereof. A sprocket 33 or equivalent member is secured to the radially inner end of the shaft 30 and a drive chain 34 or equivalent means connects thereto and extends to a conventional adjustable speed D.C. motor 72 for controlled speed drive of such inner shaft 30 which is adapted to rotate the molds in the machine of the invention on the "minor" axis, as hereinafter described in more detail. This outer sleeve 25 protrudes radially beyond the turntable 12 and a gear housing 40 is secured to the radially outer end thereof in any conventional manner. The gear housing 40 is of any desired shape and it is assembled from conventional means such as a plurality of members including plates 41, 42, 43 and 44 as shown in the drawings, and with such plates, being suitably secured together by cap screws 45, or equivalent means. FIG. 2 of the drawings best shows that a pair of the plates 42 and 44 have a mold support spindle 46 journalled therein by bearings 47 and 48. The drawings show that such mold support spindle is positioned on an operative axis at right angles to the longitudinal axis of the outer sleeve 25 and such mold spindle axis is indicated by the line A–B and is the minor axis of rotation in the machine while the outer spindle or sleeve axis C–D is the major axis of rotation of the mold support spindle 46 and obviously of any means carried thereby.

The drawings indicate that a bevel gear 50 is secured to the radially outer end of the inner shaft 30 and it engages with a companion bevel gear 51 that is secured to, or preferably formed as a unit with, the mold support spindle 46 intermediate the ends thereof whereby the engagement of the equal size gears 50 and 51 rotates the mold support spindle 46 on its axis A–B when the inner shaft 30 is driven. At the same time, when the sprocket 27 is driven, then the outer sleeve 25 causes the entire gear housing 40 and the mold support spindle 46 positioned therein to be rotated on the major axis C–D, whereby a multi-plane rotation is provided for any molds secured to ends 52 and 53 of the mold support spindle. These mold spindle ends can have any desired construction and a mold support means, indicated as a whole by the numeral 54, can be attached thereto for positioning one or more molds therein in any desired manner.

It will be realized that any desired types of controls can be provided to provide the usual automatic indexing action and movement of the turntable 12 and with the outer sleeve 25 and inner shaft 30 being continually driven as the turntable 12 moves one of the mold support means through an operative arc into the oven 18 and into the cooling station or chamber 20 so as to set up and fuse the article producing material inserted into the molds and to prepare the molds in the machine for mold opening action at the mold unloading station.

However, special controls are provided in the apparatus of the invention for certain features of operation of the present apparatus.

In the apparatus as shown, when drive is terminated for the inner shaft 30, normally a dynamic braking action is applied to the electric motor powering such shaft. Thus when the outer sleeve 25 continues to be driven, there will still be a drive of the spindle 46 on the minor axis A–B of the machine through the gears 50 and 51 and with such rotation on the axis A–B being on a 1 to 1 ratio to the drive of the outer sleeve 25. Normally, if both the inner shaft 30 and the outer sleeve 25 are being driven in the same direction, then the drive of the inner shaft 30 is cumulative in relation to the drive of the outer sleeve 25 in relation to the number of rotations provided for the mold carrying spindle 46 on its longitudinal axis A–B. It has been determined that it may be desirable to have the inner shaft 30 rotated in a reverse direction so that in such instances, the drive of the inner shaft 30 could be equal in r.p.m.'s to the drive of the outer sleeve 25, whereby the mold spindle 46 would be held stationary on its minor axis A–B, and the only rotation imparted to molds carried by the mold positioning unit 54 would be the rotation of such means about the major axis C–D of the machine.

Yet other novel controls are provided in the apparatus of the invention and they have a special physical relationship with various components of the machine to provide improved and novel control means for regulating the position of the mold carrying member 54 when the outer sleeve drive is terminated.

FIG. 3 of the drawings shows that power supply leads 60 and 61 are provided in a simplified control circuit for the apparatus and with a main drive motor for the turntable 12 being indicated at 62 and being operatively connected across the power leads 60 and 61 as hereinafter described, while operating coils for relays RR, CR–1, CR–2, CR–3 and CR–4 are indicated respectively by enclosures identified by the numerals 63, 64, 65, 66 and 166. The individual switches or sets of contacts controlled by such relays are designated by RR, CR–1, etc., and are shown as normally open or closed. In the energization circuit for the relay 63, a reset button or switch 67 is provided and it is adapted to energize the operating coil of relay 63 and then to lock one set of contacts 68 in a closed position after the reset switch 67 has been temporarily actuated. Hence, the relay 63 is maintained energized as the contacts 68 bridge across the reset switch 67.

In the diagrammatic control circuit shown, for purposes of simplicity and clarity, only one spindle control motor system has been disclosed, but similar means would be provided for the other operative spindles in the machine. Normally, the apparatus will function through an operative cycle by the controls shown in association with other conventional circuit means. The machine is started to operate by temporarily closing an index start switch 69 operatively connected to the operating coil for the relay 64. Such relay energization closes a plurality of switches, or sets of contacts indicated by the numerals 70 in the control circuits for the D.C. motor 71 controlling the outer sleeve 25 and its rotation and the second individual D.C. motor 72 for the inner shaft is also energized when the relay 64 is energized to close the normally open switches provided in the power circuits for both motors 71 and 72. Energization of the control relay 64 also closes a set of contacts 73 provided in the power circuit for the operating coil for the control relay 65, so that such relay 65 is now also energized and this closes a set of switches or contacts 74 in the control circuit for the index drive motor 62 whereby the turntable starts to rotate through a given cycle and at the same time, the motors 71 and 72 are rotating the mold assembly arms and any molds carried thereby in two planes. In the circuit shown, the drive for the motor 62 is terminated when the arcuate movement of the turntable 12 brings it to LS–1 or switch 75 at the mold opening station. The switch 75 has been closed when the turntable 12 is started to rotate by the motor 62 and ultimate movement of such turntable to the mold opening station opens the limit switch 75 and closes LS–2 or limit switch 76 that is indicated in FIG. 2 of the drawings. Such limit switch 76 is positioned on the turntable assembly and is closed by a cam 176 on the post 11 by relative arcuate movement of the turntable and associated means in relation to the frame 13 as the turntable moves an arm assembly to the mold open station. By rotation of the outer sleeve 25, still continuing, a lobe of a cam 80 on the outer sleeve is brought into operative engagement with LS–3, or limit switch 77, that is positioned on the turntable 12 is fixed relationship to the outer sleeve 25 and such switch 77 is closed. When the limit switch 77 is closed, this energizes the actuating coil for CR–4 control relay 166, and causes such control relay to open sets of contacts 81 and 82 and closes the set of contacts 83 provided in the control circuit for regulating the operation of the outer sleeve motor 71, as hereinafter described in more detail. Such action stops the drive for such motor 71.

When LS–2 is closed, rotation of the inner shaft **30** by its drive means causes a lobe of a cam **90** secured operatively to a radially inner end of the inner shaft **30** to contact an associated limit switch LS–4, indicated by the numeral **91**, and close it. This energizes the operating coil of CR–3, control relay **66**. In turn, the control relay **66** causes normally closed sets of contacts **91** and **92** in the control circuit for the motor **72** to open and at the same time it closes normally open contact **93** provided in the operative circuit or such motor **72** and stops this motor.

By the circuits shown, both motors **71** and **72** and their control circuits have a dynamic braking action exerted on the armatures thereof by the change in circuit control conditions effected by actuation of the control relays **166** and **66**, respectively, whereby such motors will cease rotation with a very limited amount of inertia movement after the control relays **166** and **66**, respectively, have been energized.

By adjustment of the position of the cam **80** and the operative lobes or fingers provided thereon in relation to the circumferential positioning of such operative lobes on the circumference of the outer sleeve **25**, such inertia travel or limited arcuate movement of the outer sleeve **25** can be regulated so that the outer sleeve **25** will terminate its rotation under the dynamic braking action with the mold support spindle **46** being on a substantially or exactly vertical axis. This enables workers operating the machine **10** to open the mold carrying member **54**, remove articles therefrom, and to recharge the mold, close the mold and have the machine ready for further operation. Then, after the molds carried on the upper end **52** of the mold support spindle have been processed, it is desirable to have the spindle **46** rotated about 180° about the major axis C–D of the machine. To achieve this action, a mold rotate switch **100** is temporarily closed and this energizes an operating coil of a control relay indicated by the letters CR and number **101**. This opens a normally closed set of contacts **102** in the operative circuit for the control relay **166** and permits contacts **81** and **82** to reclose and to open the contacts **83** to thus start the outer sleeve motor **71** for rotation of the outer sleeve **25**. The limit switch **77** is, as before, opened by such rotation of the outer sleeve as the cam **80** brings an operative lobe into engagement with the limit switch **77** after 180° of rotation to close it, energize the control relay **166** and again cause the outer sleeve motor **71** to terminate its rotation under the dynamic braking action provided. Hence the opposite end **53** of the mold support spindle **46** will be uppermost and the molds carried thereby can be opened, unloaded, and supplied with new article forming material.

In some instances, it is desirable to reverse the rotation, particularly of the inner shaft motor **72**. Thus, in the control circuit shown for both the motors **71** and **72**, a forward and reverse type of a conventional switch means **103** and **104**, respectively, are provided for the motors **71** and **72** so that at any time, the operator can reverse the rotation of either one of these motors and have them operating in opposite directions, if desired. The remaining portions of the diagrammatic circuits shown are all of conventional natures and do not need any detailed description. However, by the improved control means of the invention, a controlled stop action is obtained for the outer sleeve 25 and molds carried thereby whereby the mold carrying spindle **46** can be positioned vertically when the drive for the mold support arm **14** is terminated and this spindle **46** will be vertically positioned and can be readily rotated through 180° for complete mold processing at the mold loading and unloading station of the apparatus.

FIGS. 4 and 5 show variable resistances **110** and **111**, respectively, which are connected in the field circuits **112** and **113**, respectively, for the motors **71** and **72**. Hence, ready speed control means are provided so that any desired ratios of drive for the outer sleeve **25** and inner shaft **30** can be obtained.

From the foregoing, it is seen that novel and improved rotational casting apparatus has been provided. Hence, the objects of the invention have been realized.

While one complete embodiment of the invention has been disclosed herein, it will be appreciated that modification of this particular embodiment of the invention may be resorted to without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. In a rotational casting machine having a frame, a horizontal turntable journalled on said frame, means for rotating said turntable, and a plurality of mold support means carried by said turntable and extending radially thereof to terminate radially beyond said turntable, and where said mold support means comprise

an outer sleeve,

means on said turntable positioning said outer sleeve for rotation therein,

adjustable speed driven means engaging said outer sleeve to rotate it on a major axis,

an inner shaft journalled in said outer sleeve and extending therebeyond from both ends thereof,

adjustable speed driven means engaging the radially inner end of said shaft,

a first bevel gear secured to the radially outer end of said shaft,

a gear housing secured to the radially outer end of said outer sleeve and enclosing said first gear,

a mold spindle journalled in said gear box on a minor axis perpendicular to that of said outer sleeve and protruding from said gear box at both ends, and

a second bevel gear on said mold spindle within said gear housing and engaging said first gear,

said mold spindle being adapted to have mold carrying means attached to both ends thereof for rotation in a multiplicity of planes with rotation of said outer sleeve and said shaft.

2. In a rotational casting machine as in claim **1** where a 1 to 1 ratio exists between said first and second bevel gears and said outer sleeve will drive said mold spindle on its axis at the same speed as said outer sleeve when said inner shaft is held stationary.

3. In a rotational casting machine as in claim **1** where a 1 to 1 ratio exists between said first and second bevel gears and a D.C. motor is provided to drive said inner shaft,

means are provided to reverse the power supply to said motor, and

adjustable resistance means are present in such power supply whereby said shaft can be driven in reverse to retain said mold spindle stationary on its longitudinal axis when said outer shaft and gear housing are rotated to rotate said mold spindle on only the major axis.

4. In a rotational casting machine as in claim **1**, where

a cam is carried by said outer sleeve,

a switch is secured to said turntable and engages said cam to be actuated thereby at a predetermined position of rotation of said outer sleeve, and

circuit means connect said switch to the drive means for said outer sleeve to terminate drive therefor when said mold spindle is substantially vertical with one end up and any molds operatively secured thereto at the upper end thereof are substantially horizontially positioned.

5. In a rotational casting machine as in claim **4** where

additional circuit means connect to said first-named circuit means to actuate said outer sleeve drive means and start rotation thereof, and

said cam actuates said switch a second time after approximately 180° of rotation of said outer sleeve and said mold spindle on the major axis to stop said mold spindle with its other end up.

6. In a rotational casting machine having a frame, a horizontal turntable journalled on said frame, means for rotating said turntable, and a plurality of mold support means carried by said turntable and extending radially thereof to terminate radially beyond said turntable, and where said mold support means comprise

an outer sleeve,

adjustable speed driven means engaging said outer sleeve to rotate it on a major axis,

an inner shaft journalled in said outer sleeve and extending therebeyond from both ends thereof,

adjustable speed and reversible driven means engaging the radially inner end of said shaft,

a mold support spindle operatively journalled on an axis perpendicular to that of said outer sleeve but carried thereby for rotation therewith, said spindle also engaging said inner shaft for rotation thereby.

7. In a rotational casting machine as in claim 6, where

a cam is carried by said outer sleeve,

a switch is secured to said turntable and engages said cam to be actuated thereby at a predetermined position of rotation of said outer sleeve,

circuit means connect said switch to the drive means for said outer sleeve to terminate drive therefor

when said mold spindle is substantially vertical with one end up and any molds operatively secured thereto at the upper end thereof are substantially horizontally positioned,

additional circuit means connect to said first-named circuit means to actuate said outer sleeve drive means and start rotation thereof, and

said cam actuates said switch a second time after approximately 180° of rotation of said outer sleeve and said mold spindle on the major axis to stop said mold spindle with its other end up.

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