Sept. 12, 1961 J. R. DREVER ET AL 2,999,281

APPARATUS FOR MAKING CASTINGS

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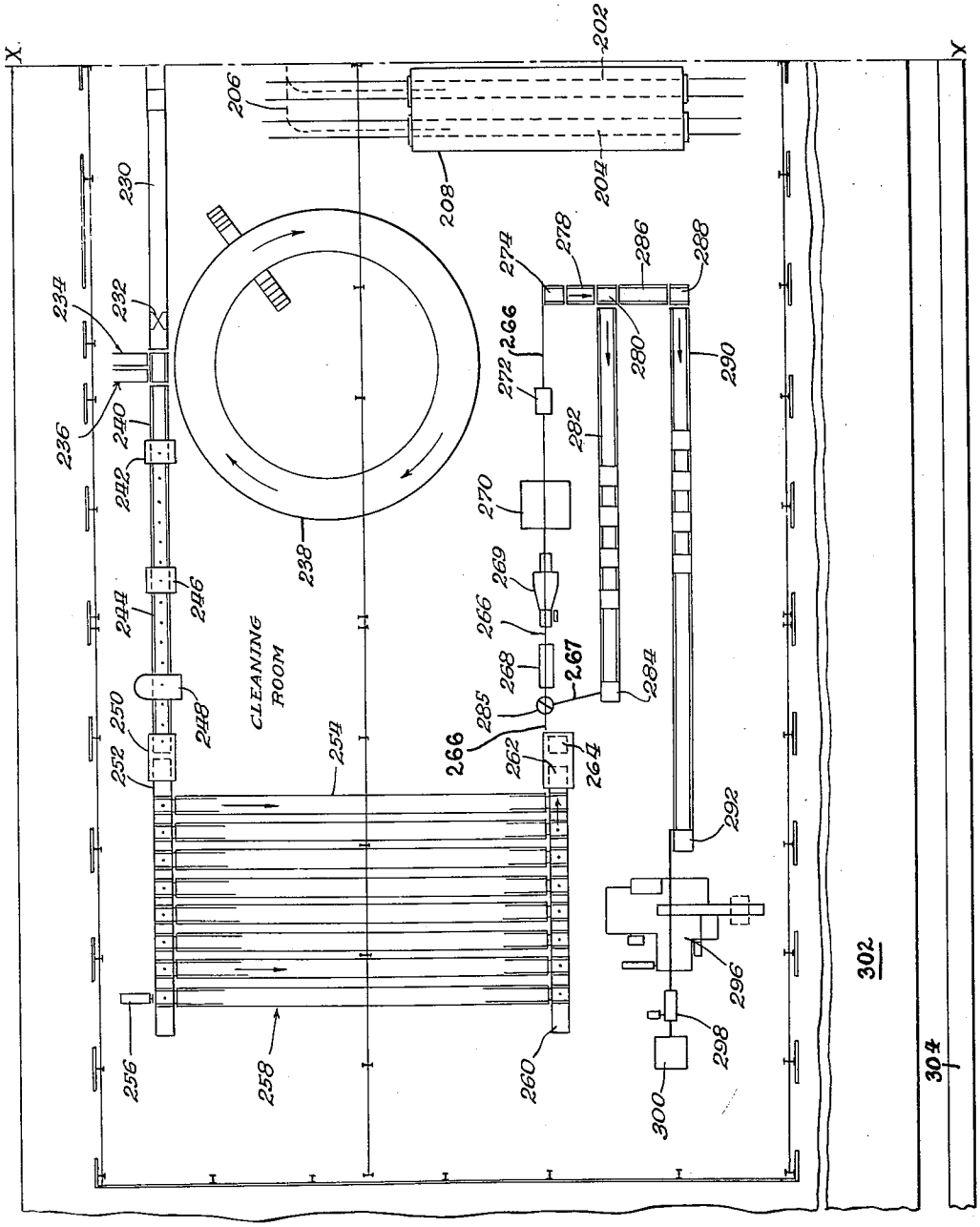


Fig. 1.

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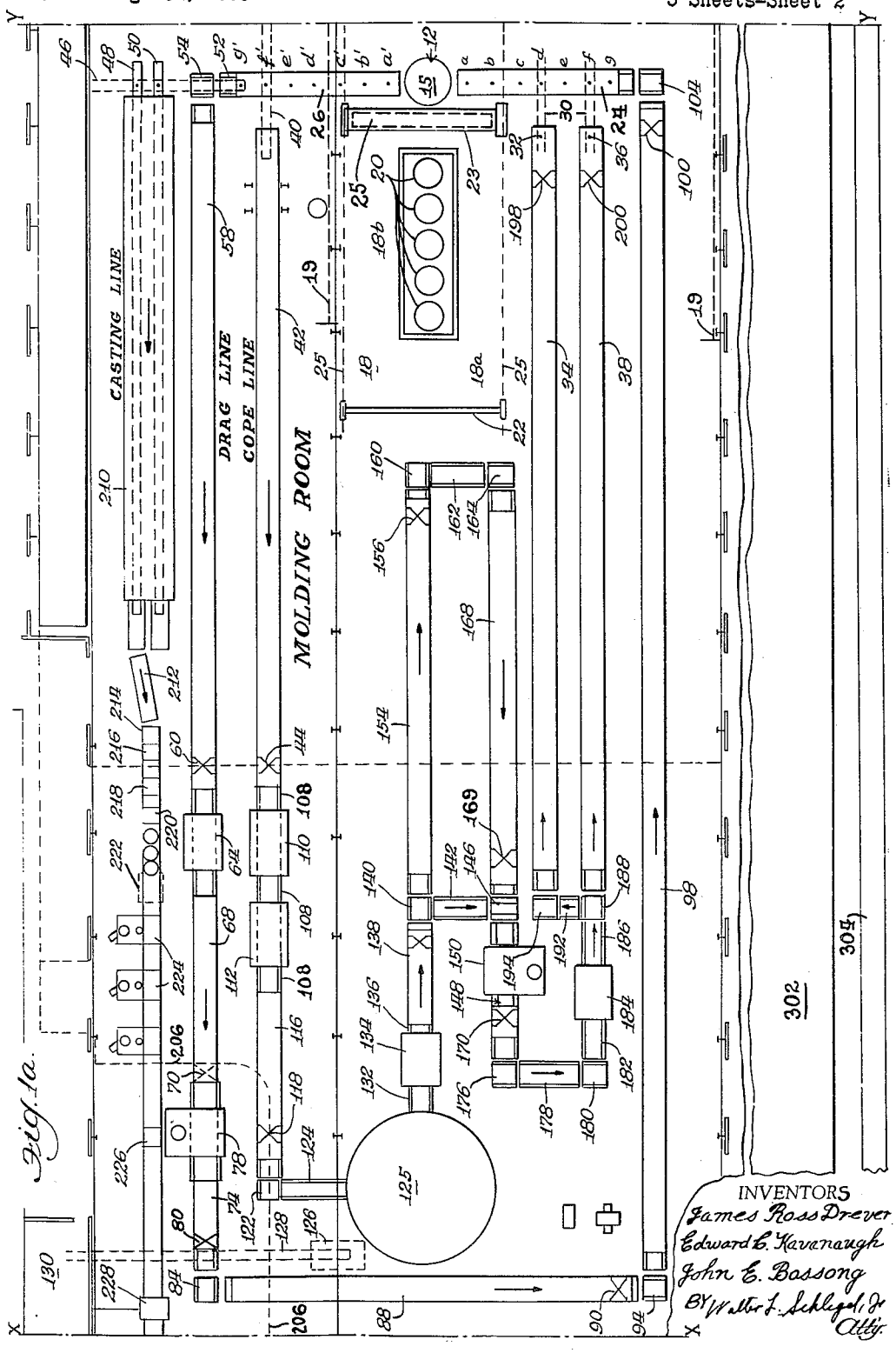


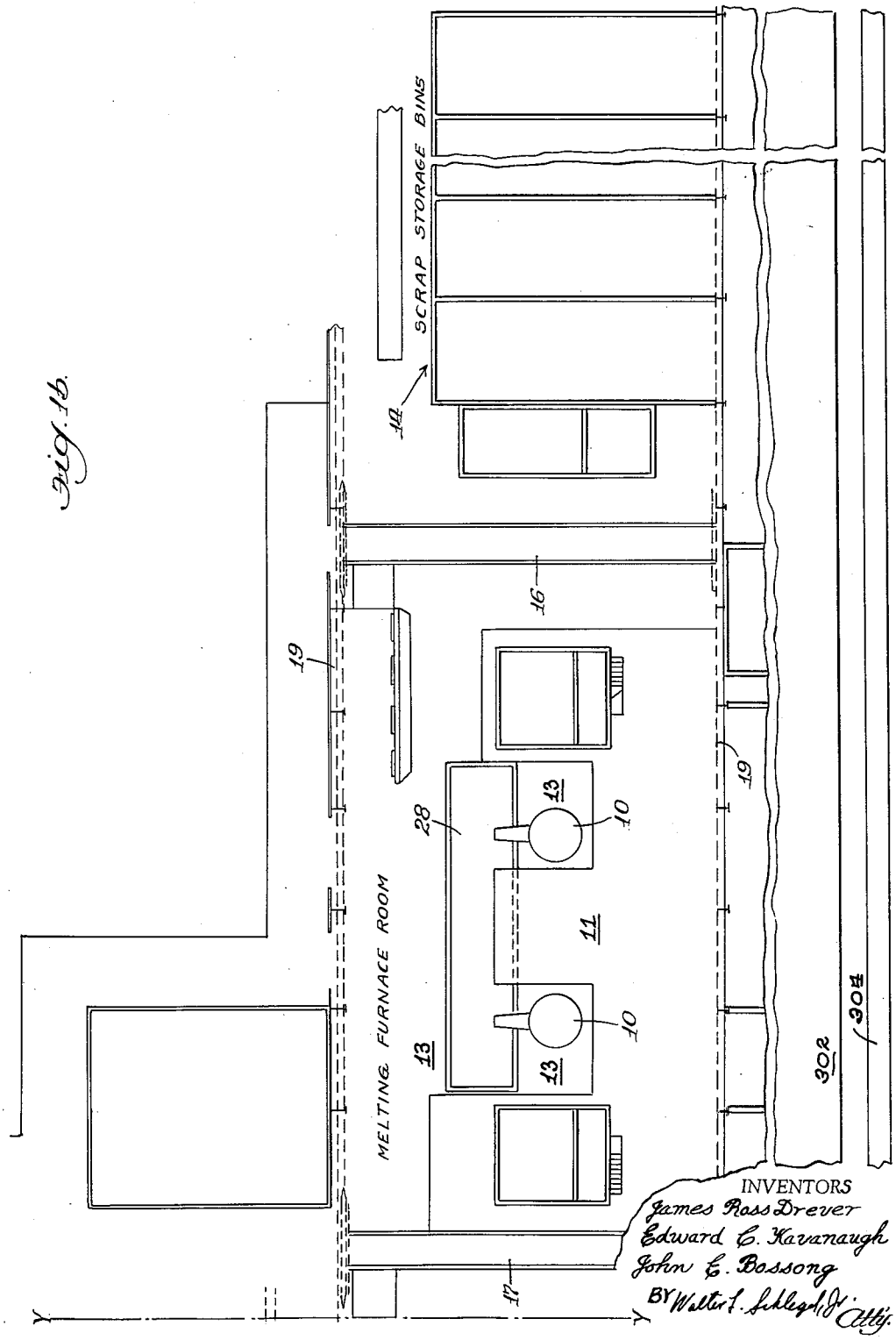
Fig. 1a.

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Fig. 1b.



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APPARATUS FOR MAKING CASTINGS

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2 Claims. (Cl. 22—64)

This invention relates to improvements in the art of metal founding and more particularly to a physical arrangement for, as well as a method of operating, a foundry plant.

The invention comprehends a lay-out of foundry plant facilities and equipment wherein all of the stations for accomplishing the necessary steps in the production of metal castings are disposed, relative to each other, and interconnected by automatic conveying means, in a manner calculated to afford their continuous operation under conditions of maximum efficiency.

Although the basic concept of assembly line production per se is not new, even to the art of metal founding, yet, the general arrangement of this invention is unlike any arrangement known to exist in the field of metal founding.

This invention is concerned with a foundry plant for producing metal castings, and particularly railway car wheels, by a process of pressure pouring molten metal into permanent molds formed of graphite blocks. The invention resides in the arrangement or disposition of, and method for operating, the foundry plant facilities embodied in this invention.

The process of producing steel castings by pressure pouring molten steel into graphite molds entails many problems of production, some of which are common to other types of casting operations and some of which are not.

It is a primary purpose of this invention, therefore, to provide a manner of arranging and operating foundry plant facilities calculated to afford maximum efficiency in production, but utilizing a minimum of time, space, and operating personnel.

It is another object of the invention to provide a method of utilizing foundry plant facilities requiring a minimum of distance between separate stations for successive casting or processing operations.

A further object of the invention is the provision of a means for utilizing foundry plant facilities which requires a minimum of manual transporting or handling of equipment.

A specific object of the invention is the provision of a means of arranging and operating foundry plant facilities wherein the melting, molding, and cleaning rooms are in longitudinal alignment with each other, with the molding room in the center, and with the pouring station being disposed immediately interjacent the pouring tube preheating furnaces and the metal melting furnaces.

A more specific object of the invention is the provision of means for arranging and operating foundry plant facilities wherein as the separate cope and drag sections of a mold are processed, they travel along enclosed rectilinear paths or routes, one of which is circumjacent the other.

These and other objects of the invention will be apparent from an examination of the following description and drawings, wherein:

FIGURE 1 is a diagrammatic plan view of a portion of a foundry plant embodying features of the invention, approximately one third of the plant being shown in this view, and

FIGURES 1*a* and 1*b* are views similar to FIGURE 1, but show other portions of the plant not shown in

FIGURE 1; FIGURES 1, 1*a*, and 1*b* are intended to be read as a single combined figure along the lines X—X and X—Y of the respective figures.

Referring now to the drawings for a better understanding of the invention, it will be seen that a foundry plant embodying features of the invention comprises three contiguous sections or divisions: the cleaning room, the molding room, and the melting furnace room, which are illustrated in FIGURES 1, 1*a*, and 1*b* respectively.

Although the details of the pouring structure and molds are not shown, as they do not form a part of this invention, it should be understood that the foundry plant to which this invention pertains is one adapted for pressure casting operations of the type disclosed in copending application Serial No. 236,324, filed July 12, 1951, now U.S. Patent No. 2,847,739, granted August 19, 1958, in the name of Edmund Q. Sylvester. In this type of casting operation, molten steel is forced by the application of fluid pressure thereagainst from a ladle, disposed within a pressure tank or container, upwardly against the force of gravity through a ceramic pouring tube mounted within the cover of the container into a bottom ingate of a mold disposed above the container and comprising cope and drag sections preferably formed of graphite. The cope section is provided with separable baked riser liners and also with a stopper assembly operable to close the ingate at the end of each pouring operation.

The essential features of this invention reside primarily in the location and arrangement of the three sections or rooms of the foundry plant, relative to each other, and in the locations and arrangement of the processing stations for the separate mold sections and for the molded castings, relative to each other.

Inasmuch as the casting process begins with the melting of the scrap metal for the heat, the lay-out of the melting furnace section or room, as seen in FIGURE 1*b*, will be described first.

The primary consideration with the location of the melting room and its facilities is that the melting furnaces, preferably two, which are indicated at **10**, and the ladle pin **28** are located adjacent and in alignment, longitudinally of the plant, with the area of pouring or casting, hereinafter referred to as the pouring station, indicated generally at **12**. Furnaces **10** are preferably mounted on the ground floor of the foundry so that the furnace doors are accessible from a mezzanine **11** and so that the foundation of the furnaces are accessible from the floor **13** itself.

Although the melting furnace section of the plant includes numerous subdivisions such as the mold repair shop, machine shop, laboratory, and other sub-sections (not shown on the drawings), the other important subsection shown on the drawings is the scrap bin area indicated generally at **14**, which is disposed on the opposite side of the melting furnaces from the pouring station and in longitudinal alignment with both the melting furnaces and the pouring station so as to afford accessibility for a pair of traveling bridge cranes **16** and **17** on a common track **19** to all three stations or sub-sections **12**, **28**, and **14** of the plant.

Now turning to FIGURE 1*a* of the drawing, it will be seen that there is located immediately adjacent and to the left of the pouring station a tube processing area **18**, which includes a tube repairing area **18***a* and a tube preheating area **18***b*. Area **18***b* contains a plurality of furnaces **20** which may be used in preheating the ceramic pouring tubes employed in the pouring operation. The location of the tube processing area affords accessibility for a pair of smaller longitudinally traveling bridge cranes **22** and **23** which operate on a common track **25**.

Crane **22** on the left, as seen in FIGURE 1*a*, is known

as the tube handling crane, and is used to transfer the pouring tubes from the tube processing and repair area to and from furnaces 20. Crane 23, on the right, is known as the pouring crane and is used to transfer the pouring tubes to the pouring tank 15 in the pouring station 12. Crane 23 is also provided with a sub-crane or transversely traveling mechanism 25 which is operable to transfer molds to and from the pouring station from conveyors 24 and 26 in a manner hereinafter described.

Disposed adjacent opposite sides of pouring station 12 are a pair of aligned reciprocating pusher conveyors extending transversely of the foundry plant. The reciprocating pushing conveyor 24 on the lower side of the drawing is employed in the pre-pour operation, and the reciprocating pusher conveyor 26 on the upper side of the drawing is employed in the post-pouring operation.

Each reciprocating pushing conveyor (not shown in detail) is of the conventional type comprising a plurality of rollers for supporting the mold sections and a hydraulically actuated reciprocating beam disposed below the rollers and having a plurality of dogs for connection to the mold sections on the rollers. The beam is moved in one direction a predetermined distance, in the case of conveyors 24 and 26 the distance is five feet. In operation, this beam moves five feet, thereby advancing each mold section to which it is connected a distance of five feet or in other words advances each mold section one station. After moving forward five feet, or one increment, the beam returns to its original position, without moving the mold sections, and repeats the original movement. Thus it will be apparent that once a mold section is placed on position (*g*) of conveyor 24 or position (*a'*) of conveyor 26, it passes through all of the intermediate stations on the conveyor before leaving the conveyor unless it is lifted off of the conveyor before it reaches the last station on the conveyor.

Inasmuch as the disposition of the facilities and equipment of the molding and cleaning room sections of the foundry plant, like those of the melting room section, are interwoven with their operation, it is believed that the invention can best be described by explaining the various operations of a complete cycle in the casting process at the same time, in order to avoid unnecessary repetition.

To return first briefly to the operations of the melting room facilities, it will be understood that the charge is transported from the scrap storage bins 14 to the melting furnaces 10 by crane 16.

The furnaces 10, preferably two in number, are each preferably of fourteen ton capacity and will supply a heat sufficient to pour a minimum of 30 castings of at least 750 pounds each. In this example, the castings to be poured are railway car wheels and the plant is designed to produce a maximum of approximately 240 wheels per eight-hour shift, or in other words, 720 castings per twenty-four hour working day. As the melting time of each furnace is approximately 2 hours and the cycle of operation of the mold processing operation, hereinafter described in detail, is approximately 30 complete molds per hour, by alternating the heats from the two furnaces, it will be seen that each hour one or the other of the furnaces will produce a heat sufficient to form 30 castings or one complete cycle with respect to the processing of complete molds.

To begin the casting operation, a heat is tapped from one of the furnaces to a ladle (not shown) located in pit 28, which is just slightly below ground floor level, and the ladle is transported by crane 17 and lowered into a below floor level pit or pressure tank 15 at pouring station 12.

A pouring tube and tank cover assembly (not shown) but disclosed in said copending application are then transported by crane 23 to pouring station 12 where the tube and cover assembly are lowered onto the tank with the tube disposed to extend down into the filled ladle and with the cover closing the top of the tank around the tube.

A drag assembly comprising a mold drag section and retainer (not shown, but hereinafter referred to as a drag) is transported by conveyor 24 from position (*g*) thereon to close down position (*d*) or (*f*) thereon, whereat either one of a pair of longitudinally traveling mold closedown cranes 30 pick up a cope assembly comprising a mold cope section and retainer (not shown, but hereinafter referred to as a cope) from position 32 of cope conveyor 34 or position 36 of cope conveyor 38 and places it on the adjacent drag to close down the mold. The assembled mold is then transported by conveyor 24 to position (*a*) thereon where it is picked up by crane 23 and placed in position over the pouring tank. After the mold is checked and miscellaneous steps, not essential parts of this invention, are completed, the mold is filled and is then transported by pouring crane 23 to position (*a'*) of conveyor 26 as a new mold is placed over pit 15. During pouring of successive molds, the crane 23 remains over the pit 12 with the mold sections being carried by mechanism 25 of crane 23.

The complete mold containing the casting (not shown) is then moved by conveyor 26 from position (*a'*) to position (*f'*) thereon. At position (*f'*) the cope is picked up by a longitudinally traveling cope splitting crane 40 and transported to the adjacent end of a roller flight chain type cope conveyor 42 which moves the cope along to the automatic feed control device or stop 44. Conveyor 42, like the other roller flight chain type conveyors hereinafter referred to, is a continuously moving endless power driven chain type conveyor. Stop 44, like the other stops or feed control devices hereinafter referred to, merely comprises a mechanism including arms movable into a position to engage and block further movement of an article traveling along the conveyor, while the conveyor itself continues to move. The stops can be released automatically or manually, as necessary, so as to release one article at a time.

After the cope has been removed and placed on cope conveyor 42, the drag containing the casting is moved by conveyor 26 to position (*g'*) thereon at which point the casting is picked up from the drag by a transversely traveling hot wheel transfer crane 46 and placed on the end of either one of a pair of chain driven wheel kiln slat type conveyors 48 and 50.

After the wheel has been removed, the drag is moved from conveyor 26 by the powered rollers 52, at the end of the conveyor, which rollers 52 move the drag to the powered roller turntable 54 which in turn rotates 90° in a clockwise direction and deposits the drag on the end of power driven roller chain type conveyor 58. Turntable 54 (not shown in detail) like all of the other turntables hereinafter described except turntable 285, comprises a base and table rotatable thereon provided with powered rollers which receive an article to be moved, stop moving while the table rotates, and then move the article off the table to another set of powered rollers which move the article on to the next conveyor. The turntables can be set to operate automatically or by push button so as to move only one article at a time as it is released by a feed control device. In all cases, feed control devices are located in front of the turntables except in the case of turntable 52 where one is not needed because of the nature of the movement of reciprocating pusher conveyor 26.

In order to describe the remainder of the plant facilities and their operations, the processing routes of the drags, copes, and the castings, respectively, will be discussed in that order.

Conveyor 58 transports the drags along to stop 60, behind which drags on conveyor 58 can accumulate to be released one at a time automatically by feed control device or stop 60 to drag cleaning station 64 where the drag is automatically tipped up at an angle to permit the removal of any foreign material from the upwardly facing drag cavity and to permit cleaning of the drag cavity surface and general inspection of the drag. The

drag is then returned to horizontal position with the mold cavity facing upwardly.

After the cleaning operation, the drags are moved by roller chain conveyor **68** to stop **70** where drags can accumulate to be released one at a time. Roller chain conveyor **68** moves each drag to drag spraying station **78** whereat the drag cavity surface is sprayed with a mold wash or coating.

Although the details are not shown, it will be understood that the drag spraying station or booth (as well as at the hereinafter described cope spraying station) may be equipped with automatic means to lift and rotate the drag as the mold wash is being sprayed on.

After the drag spraying operation is completed, roller chain conveyor **74** moves the drags to stop **80** thereon. As each drag is released by stop **80**, it is transported by conveyor **74** to power roller turntable **84** where it is moved onto roller chain conveyor **88** and transported thereby through stop **90** and turntable **94** to roller chain conveyor **98** which moves the drags to stop **100**. At this point, one drag at a time can be released and moved onto turntable **104** and from there to position (*g*) of conveyor **24** and then by conveyor **24** to position (*f*) thereon, thus ending the cycle of processing for the drag.

After the copes have been picked up by crane **40** from station (*f'*) of conveyor **26** and moved to roller chain conveyor **42**, they are moved to stop **44** at which point they can be released one at a time. As each cope is released, it is moved by power roller conveyor **108** to station **110** where it is tipped up at an angle and the used core and riser liners are removed. The cope is then returned to horizontal position and moved to station **112** where it is again tipped up at an angle and turned to permit cleaning from the other side. After the cleaning operation, each cope is returned to horizontal position and moved out of station **112** by conveyor **108** to roller chain conveyor **116** with the mold cavity facing downward. The copes move along conveyor **116** until they encounter stop **118** where they are accumulated and released one at a time for movement onto power turntable **122** where each cope is rotated 90° in a clockwise direction and moved onto power roller conveyor **124**. Conveyor **124** moves each cope onto a rotating multi-position core baking table **125** located adjacent the riser liner station **126**. Sand may be supplied to the station by an overhead conveyor **128** from sand bins or silos **130** located nearby.

After the sand is put in the riser liners in the copes, the cores or liners are baked as baking table **125** rotates in a counter-clockwise direction. As the table is indexed, one completed cope at a time is ejected from the table and picked up by power roller conveyor **132** and moved to roll over station **134** where the cope is rotated 180° and positioned with mold cavity surface facing upwardly on roller chain conveyor **136**. The copes are then moved by the conveyor to stop **138** where one cope at a time is released and moved to turntable **140**. At this point, if a cope has cooled to a temperature low enough to permit application of a mold wash, turntable **140** is rotated 90° in a counter-clockwise direction and moves the cope onto conveyor **142** which in turn moves the cope to turntable **146** where the cope is again rotated 90° in a counter-clockwise direction and moved by roller chain conveyor **148** to spray booth or spraying station **150**.

If, when the copes reach turntable **140**, they are too hot for proper spraying of the mold wash, turntable **140** is not rotated and the copes are moved along a bypass or cooling circuit by power chain conveyor **154** to stop **156** where they are released one at a time and moved to turntable **160**, rotated 90° in a counter-clockwise direction, and then moved by power rollers **162** to turntable **164** where they are again rotated 90° in a counter-clockwise direction and moved to roller chain conveyor **168**. The copes can accumulate on conveyor **168** in back of stop **169** and can remain in the bypass circuit until cool enough to spray, at which time, they can be released one at a time and moved to turntable **146**, from where they are moved by conveyor **148** to spray booth **150**.

At spray booth or station **150**, the cope can be lifted and rotated while being sprayed with a mold wash solution and then can be moved to turntable **176** where it is rotated 90° in a clockwise direction and moved by power rollers **178** to turntable **180** and again rotated 90° in a clockwise direction and moved by conveyor **182** to a roll-over device **184** where the cope is rotated 90° where the stopper is set. The mold is then rotated 180° where the hair pin hook, which fastens the stopper in position, is attached. Then the mold is rotated 90° to place the mold cavity downwardly again.

At this point, the copes are moved by conveyor **186** to turntable **188** where they can be either moved to roller chain conveyor **38** or else can be moved by power rollers **192** to turntable **194** and then, after being rotated 90° in a counter-clockwise direction, be moved to roller chain conveyor **34**. Conveyors **34** and **38** each hold approximately 32 copes, and normally one conveyor is filled before the other. In the case of wheel castings of different weights, one conveyor can be used for one type and the other conveyor for the other type. Thus, the cope processing cycle is completed and the copes are accumulated on conveyors **34** and **38** in front of stops **198** and **200**, respectively, in position to be released for the beginning of the next cycle.

Thus, it will be seen that there are provided generally parallel cope and drag processing assembly line type routes compactly and efficiently arranged and disposed in two generally rectilinear closed circuits with the drag circuit being circumjacent the cope circuit and both paralleling for the most part the adjacent wheel processing circuit.

The purpose of enclosure **208** is to preheat new molds. Conveyors **202** and **204** are to convey new and remachined molds through the preheat furnace. Monorail **206** is the means whereby molds are placed in and removed from the process cycle.

FIGURES 1 and 1*a* show the processing of the casting, which in this example is a steel railway car wheel, after it leaves the pouring station. The wheels are poured at approximately 2,900° F. and, although they cool to some extent while on conveyor **26**, they are still at temperatures of approximately 1,500° F. when they are placed on power slat type conveyors **48** or **50** of the wheel kiln **210** by crane **46**.

The wheel kiln **210**, although enclosed to retain some heat therein, is not provided with any heating means and its sole purpose is to permit the still hot wheels placed therein to cool gradually from an initial temperature of approximately 1,500° F. down to approximately 900° F. to 1,000 F. As the wheels leave the wheel kiln on either power slat type conveyor **48** or **50** they pass through an intermediate alligator switch **212**, the position of which may be altered to receive wheels from either conveyor **48** or conveyor **50**, down to another wheel process line gravity conveyor **214** where they pass through several stations and are subjected to various finishing processes.

The first station each wheel enters as it passes down conveyor **214** is the sprue removal station **216**, where the sprues are removed from each wheel. Next, each wheel passes through a roll-over device **218**, after which the residual ceramic stopper is chipped off at station **220**. The wheel progresses to stamping press **222** where it is hot stamped with the necessary markings. Next, the wheel passes to station **224** where one or more hub cutting devices are provided to torch cut a bore through the center of the hub. From there, the wheel continues down gravity conveyor **214** to station **226** where the wheel is rolled over so that it is now back in its original position with the flange down. The wheel then passes

down to a vertical lift **228**, the function of which is to raise the wheel to proper elevation to set it into the annealing furnace. The wheels are moved by gravity conveyor **230** to stop **232**, as they are released from the stop **232**, one at a time, they are automatically picked up by a manipulator, indicated generally at **234**, and transported to a rotating heat treatment furnace **238**. The furnace is provided with a plurality of indexed stops so that each time one wheel is rotated from one position to the next, another wheel is automatically added by the manipulator **234** and another wheel is automatically removed from the furnace by a second manipulator **236** and placed on gravity conveyor **240**.

The castings remain in the rotating furnace **238** for a heat treatment that lasts approximately 1½ hours, which represents the time it takes for one complete revolution of the furnace. The castings enter the furnace at a temperature of approximately 600° F. and leave the furnace at a temperature of approximately 1,600° F.

The wheel is moved by conveyor **240** to a conventional lowerator device **242**, the function of which is to lower the wheel from conveyor **240** onto an endless conveyor **244**.

As the wheels are moved along conveyor **244**, they pass through hub cooling stations **246** and **248** where the heavier sections or hubs of the wheels are cooled by the application of compressed air thereagainst for a short period and then by the application of a fine spray of water thereagainst for a short period of time. All the time that the wheels are on conveyor **244**, the entire surface of each wheel is, of course, air cooled by the atmosphere surrounding the conveyor which is at room temperature.

As the wheels reach the end of the conveyor, they are moved into a stacking device **250**, which automatically stacks the wheels in piles three high and places them on rollerchain conveyor **252**, which transports them to any one of a plurality (preferably 8) of normally disposed chain conveyors **254**. The stacks of wheels are successively positioned on the respective conveyors **254** by a plurality of horizontal pusher mechanisms **256** (only one of which is shown). Each conveyor **254** is adapted to hold 20 stacks of 3 wheels each or, in other words 60 wheels. Thus, it will be seen that with 8 conveyors holding 60 wheels each, the wheel storage area, indicated generally at **258** is capable of holding 480 wheels or, in other words all the wheels cast in two 8 hour shifts. Thus, by the time the wheels are taken out of the wheel storage they have cooled at least 16 hours and are now cool enough for the final processing. After the wheels are moved by conveyors **254** to the conveyor **260**, they are moved to a de-stacker **262** which separates the wheels from their stacks and passes them into an upender **264** where each wheel is moved to a vertical position and placed onto a downwardly sloping rail **266**. It rolls down rail **266** to station **268** where it passes through a flange grinding process. The wheels then move along rail **266** to a wheelabrator **269** where they are subjected to shot blasting to clean the surfaces of the wheels. From there they move on rail **266** by force of gravity to stations **270** and **272** where they are inspected by a magnaglo process and by visual examination. They then continue on rail **266** to a downender at station **274** where they are returned to a horizontal position again. Any wheels which are found to be defective at this time are removed from the line and taken back to the scrap bins. If the wheels merely need a slight additional grinding, they pass through roller conveyors **278**, through turntable **280** to conveyor **282** where they are submitted to further grinding operations and, then pass to turntable **284**, where they are upended and placed on a sloping rail **267** and pass to turntable where they are moved while in a vertical position onto rail **266** again and return through the previously described circuit. If the wheels are in proper condition, after reaching turntable **280**, they are moved by conveyor **286** to turntable **288** and thence by conveyor **290** to the upender **292** which places them in vertical position in order that they may be introduced to the hub boring machine, indicated generally at **296**. At this station, the hubs are bored and the wheels are then submitted to a final inspection at station **298** and weighed at station **300**. The wheels are then ready for transmission to the loading platform **302**, preparatory for loading on railway cars (not shown) or track **304**.

We claim:

1. In an arrangement for continuously producing metal castings by forcing molten metal into permanent molds each comprising cope and drag mold sections and a pouring tube through which the metal is forced under pressure into the mold, the combination of: a pouring station for producing the castings; an open conveyor circuit for transporting castings from the pouring station through a plurality of casting processing stations; a closed conveyor circuit for transporting the drag sections from the pouring station through a plurality of drag processing stations and back to the pouring station; another closed conveyor circuit for transporting the cope sections from the pouring station through a plurality of cope processing stations and back to the pouring station; said pouring station being disposed in a generally straight conveyor line which forms a common part of all three previously mentioned circuits; a pouring tube preheat station adjacent the conveyor line and in close proximity to the pouring station; a mold assembly station in said straight conveyor line immediately preceding the pouring station; means for transferring preheated tubes to said pouring station; and a mold disassembly station in said straight conveyor line following said pouring station.

2. In an arrangement for continuously producing metal castings by forcing molten metal into permanent molds each comprising cope and drag mold sections and a refractory pouring tube through which the metal is forced under pressure into the mold, the combination of: a pouring station for producing the castings; an open conveyor circuit for transporting castings from the pouring station through a plurality of casting processing stations, a portion of said circuit lying in a straight line path; a closed conveyor circuit for transporting the drag sections from the pouring station through a plurality of drag processing stations and back to the pouring station; another closed conveyor circuit for transporting the cope sections from the pouring station through a plurality of cope processing stations and back to the pouring station; said straight line path forming a common part of all three previously mentioned circuits; a tube preheat station adjacent the straight line path and in close proximity to the pouring station; a mold assembly station in said straight line path immediately preceding the pouring station; means for transferring preheated pouring tubes to said pouring station; and a mold disassembly station in said straight line path following said pouring station.

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