April 24, 1956 P. M. PAYNE 2,742,682

CONTINUOUS MOLDING APPARATUS

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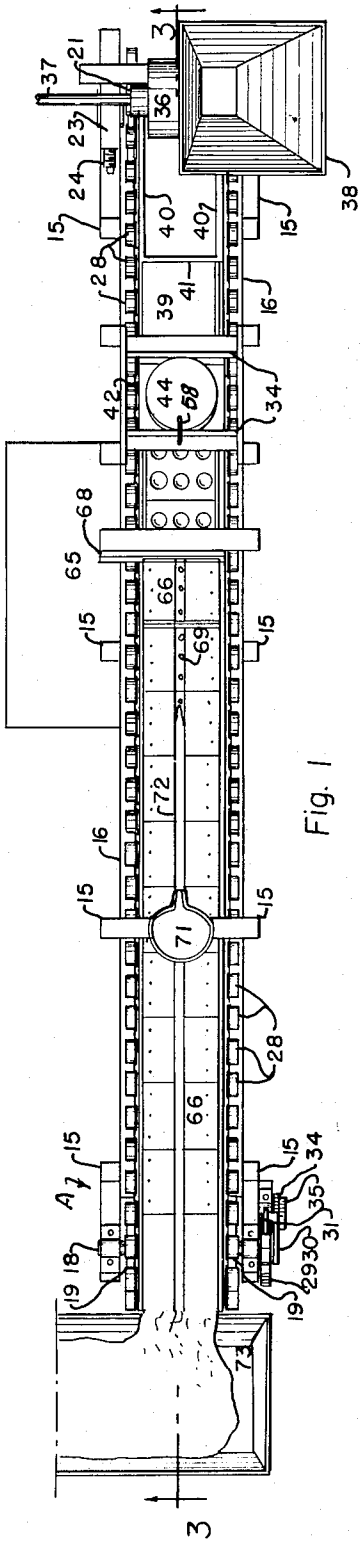


Fig. 1

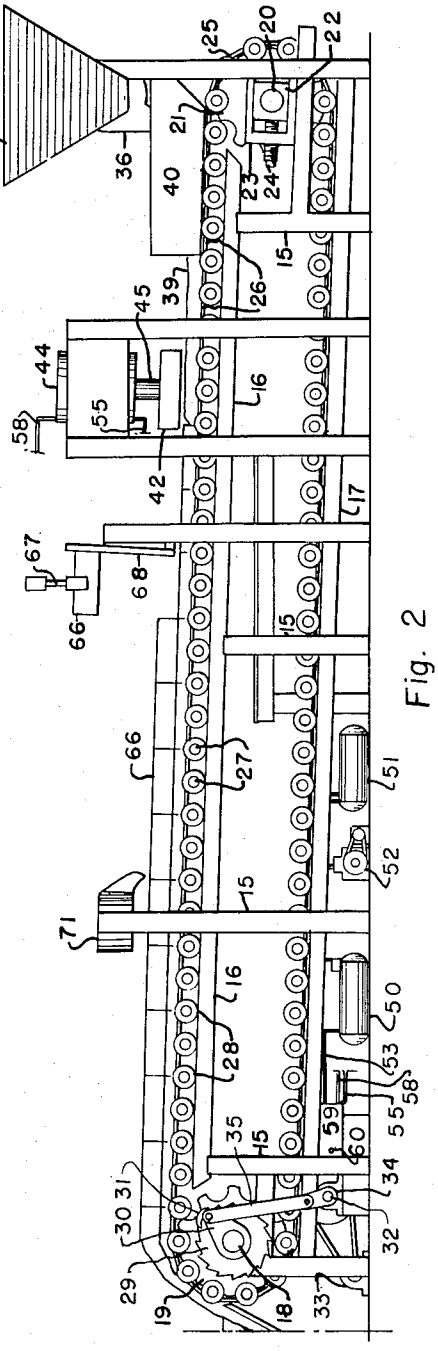


Fig. 2

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CONTINUOUS MOLDING APPARATUS

Filed May 5, 1952 3 Sheets-Sheet 2

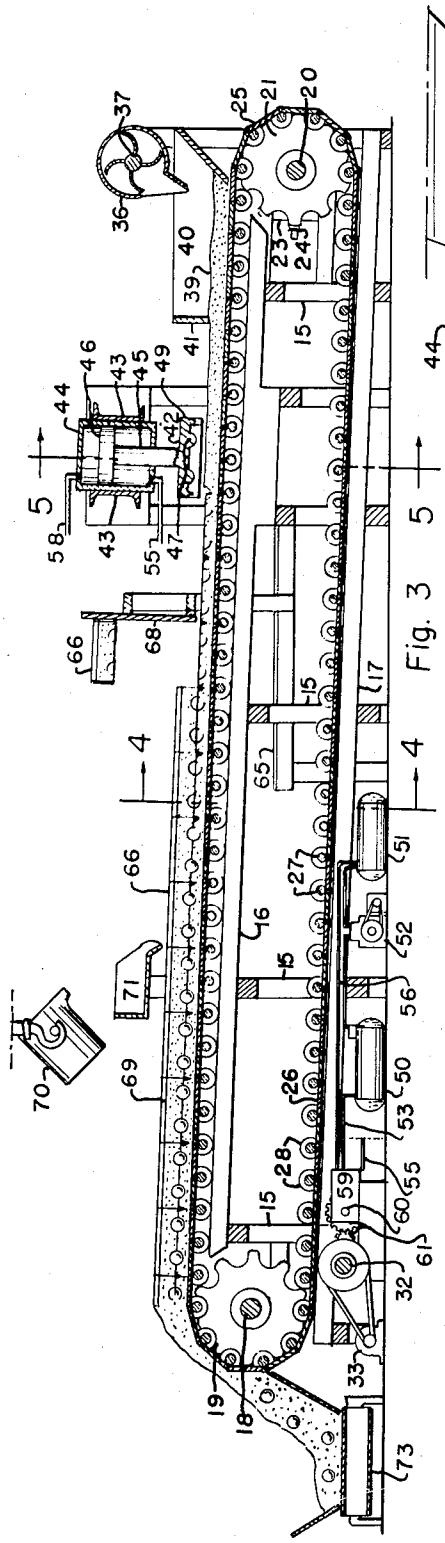


Fig. 3

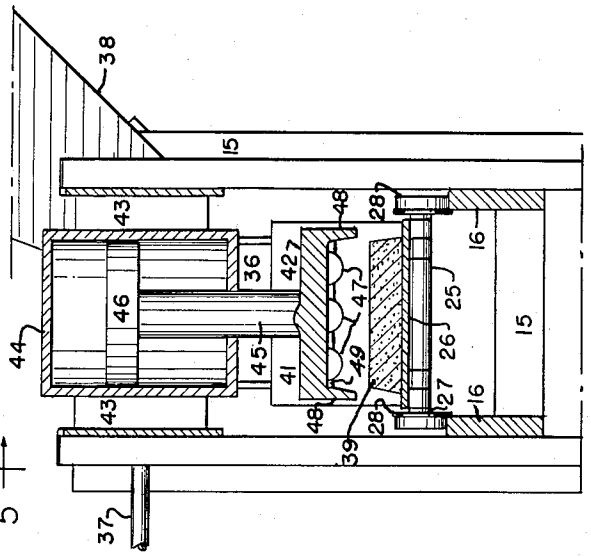


Fig. 5

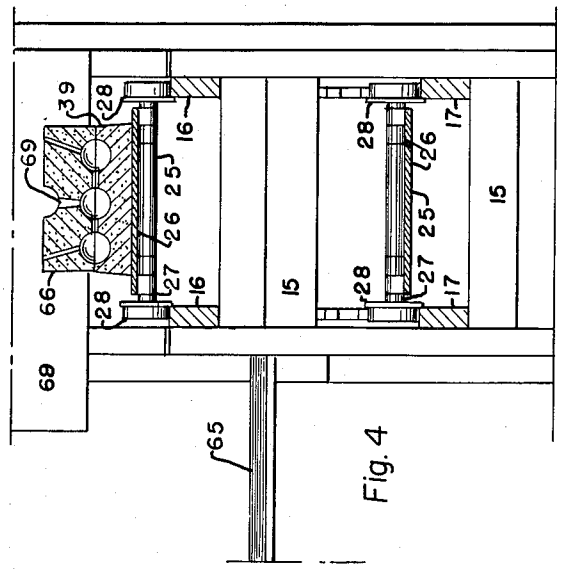


Fig. 4

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CONTINUOUS MOLDING APPARATUS

Filed May 5, 1952 3 Sheets-Sheet 3

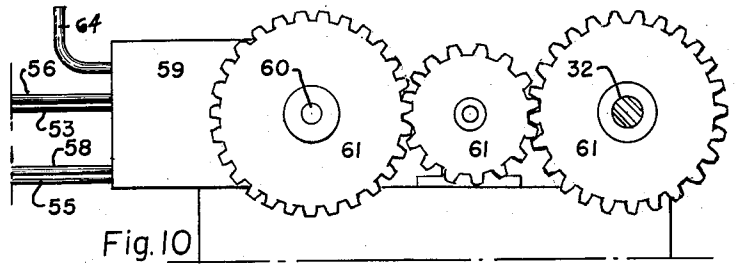


Fig. 10

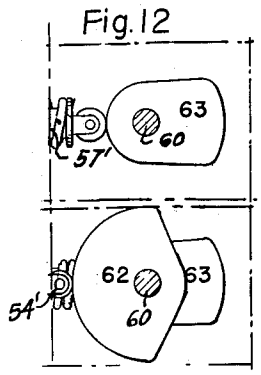


Fig. 13

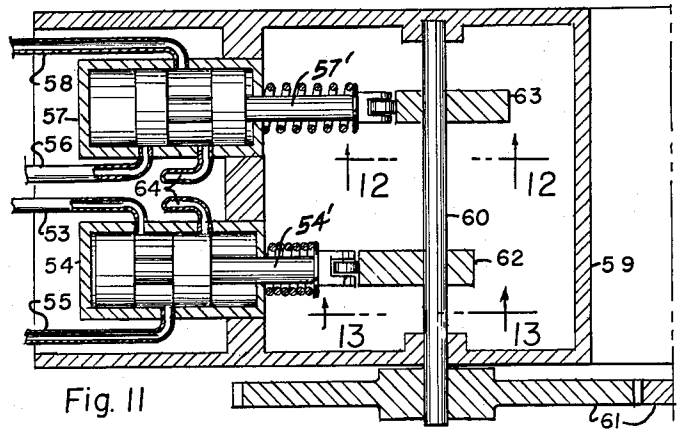


Fig. 11

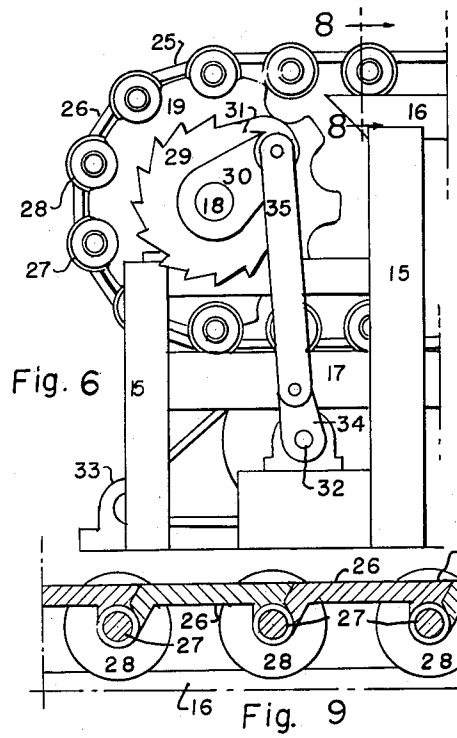


Fig. 6

Fig. 9

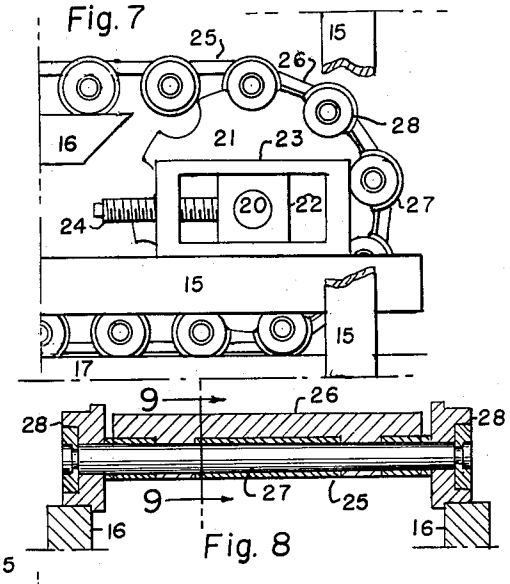


Fig. 7

Fig. 8

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United States Patent Office 2,742,682 Patented Apr. 24, 1956

2,742,682

CONTINUOUS MOLDING APPARATUS

Pearson M. Payne, Denver, Colo.

Application May 5, 1952, Serial No. 286,099

6 Claims. (Cl. 22—20)

As a development from and a continuation in part of the disclosures characterizing my application for Letters Patent of the United States filed April 20, 1950, Serial No. 157,105, series of 1948, now abandoned, this invention relates to the production of shapes and articles of cast metal, and more particularly to such production effected through the agency of "green sand" molds, and has as an object to provide an improved apparatus operable for the continuous production of cast metal products.

A further object of the invention is to provide improved means for the continuous casting of metal products in "green sand" molds.

A further object of the invention is to provide improved means for developing and patterning a continuous "green sand" mold drag susceptible of operative correlation with mold cope sections in a continuous casting operation.

A further object of the invention is to provide improved apparatus continuously operable to give effect to improved principles of metal casting as applied to the quantity production of cast metal products in "green sand" molds.

A further object of the invention is to provide an improved means for the continuous quantity production of cast metal products which is efficient and economical of operation, adaptable to use in the casting of highly diverse items, susceptible of operative development in various sizes and capacities, and which economically facilitates the use of "green sand" as a molding medium.

With the foregoing and other objects in view, my invention consists in the construction, arrangement, and combination of elements constituting apparatus, all as hereinafter set forth, pointed out in my claims, and illustrated by the accompanying drawings, in which—

Figure 1 is a top plan view of typical apparatus operable to give effect to the principles of the invention as manifest in practice of the improved method. Figure 2 is a side elevation of the organization according to Figure 1, an end portion of the assembly being broken away to conserve space. Figure 3 is a vertical section longitudinally through the organization according to the preceding views taken substantially on the indicated line 3—3 of Figure 1. Figure 4 is a cross section, on a relatively enlarged scale, taken substantially on the indicated line 4—4 of Figure 3. Figure 5 is a cross section, on the same scale as Figure 4, taken substantially on the indicated line 5—5 of Figure 3. Figure 6 is a fragmentary, detail elevation, on a relatively enlarged scale, of the conveyor mounting and drive means shown at the left-hand end of Figure 2. Figure 7 is a fragmentary, detail elevation, on the same scale as Figure 6, of the adjustable conveyor mounting means shown at the right-hand end of Figure 2. Figure 8 is a fragmentary, detail section, on a further enlarged scale, taken substantially on the indicated line 8—8 of Figure 6. Figure 9 is a fragmentary, detail section taken substantially on the indicated line 9—9 of Figure 8. Figure 10 is a side elevation, on a relatively enlarged scale, of an actuating control assembly employed in synchronous correlation with the conveyor drive of the illustrated organization and as viewed from the approximate position indicated by the arrow A in Figure 1. Figure 11 is a transverse section taken substantially on the indicated line 11—11 of Figure 10. Figure 12 is a fragmentary, detail section taken substantially on the indicated line 12—12 of Figure 11. Figure 13 is a fragmentary, detail section taken substantially on the indicated line 13—13 of Figure 11.

The application of conventional founding principles to the production of cast metal objects in "green sand" molds is wide-spread and fully established as economical and efficient save for the intermittent characteristic consequent upon the use of separable, flask-confined cope and drag sections of the mold. In conventional practice, it is rarely feasible to use a "green sand" mold section, either cope or drag, more than a few times before the sand portion of the section must be renewed or rehabilitated, and in a great many instances a single use of the mold section is the maximum attainable. Many cast metal items are adapted for production in "green sand" molds and are desired in quantities adapted for continuous volume production, hence the instant invention is directed to the provision of a novel method and of improved means applicable to the development and patterning of a continuous "green sand" mold drag portion in a manner adapting the drag for cooperation with separate cope sections arranged for the reception of molten metal in accordance with principles enhancing the economy, efficiency, and product quality of the molding operation.

Distinguishing from the conventional practice of founding in "green sand" molds with adaptation of the advantages of such practice to continuous operations, the improved method consists of continuously forming and translating a "green sand" mold drag portion, intermittently and automatically patterning and simultaneously compressing successive sections of said drag portion in synchronism with the drag portion travel, successively associating mold cope portions with the packed sections of the drag portion for completion of molds ready for the reception of metal, developing a metal flow and feed trough as an incident of such cope portion assembly, and flowing metal within said trough for mold charging in a manner effective to cause charged mold translation beneath the trough-extended length of the molten charging metal subsequent to completion of the individual mold charge.

Apparatus for practice of the improved method may vary through many particular forms and constructions characterized by the operatively essential features and relationships typified by the views of the drawing and hereinafter elaborated. As illustrated, an elongated, rigid frame 15 is suitably constructed in any desired particularity to include a pair of straight, spacedly-parallel, upper track members 16 extending the length thereof in registration with and spaced parallelism above similar, lower track members 17, which track members are fixedly associated with their supporting frame 15 to slope longitudinally from a lower and to a higher end at an inclination on the order of some five degrees from the horizontal. Outwardly adjacent and between the higher ends of the track members 16 and 17 the frame 15 rotatably supports a transversely-disposed shaft 18 carrying spaced sprockets 19 and in analogous relation with the lower ends of said track members a similar shaft 20 carrying spaced sprockets 21 is mounted for rotation in spaced parallelism with said shaft 18 and for adjustment of the spacing therebetween, which adjustment is expediently the function of bearing blocks 22 rotatably carrying the ends of the shaft 20 and themselves shiftable longitudinally of the

frame 15 in frame-fixed guides 23 under the influence of adjusting screws 24 threadedly associated with and through inner sides of said guides. An endless, link-type conveyor 25 adapted to translatably support a continuous "green sand" mold drag portion is constituted as a close succession of transversely-disposed, flat metal plates 26 hingedly interlinked at their adjacent and coacting margins by means of pins 27 which carry flanged rollers 28 on their ends at the opposite sides of the plate assembly in position for engagement with and rolling travel along upper margins of the track members 16 and 17 when said conveyor is engaged over and about, and to extend between, the sprockets 19 and 21 at the opposite end of said track members, as illustrated. Operatively associated with the frame 15 and track members 16 and 17 as shown and described, the conveyor 25 is disposed for travel longitudinally of the said frame and track members with its upper run supported through engagement of the rollers 28 on the upper track members 16 as a straight, flat, coplanar succession of the plates 26 exposed for reception and translation of material deposited thereon, with its lower run roller-supported on the lower track members 17, with the rollers 28 of its end bends engaged by and in the peripheral notches of the corresponding sprockets, and subject to appropriate tensioning through the agency of the screws 24, so that rotation of either of the shafts 18 or 20 will act to drive the conveyor in an obvious manner.

To accomplish the purposes of the invention, the conveyor 25 is driven for translation of its upper run from the lower and to the higher end of the assembly with a uniformly-intermittent motion marked by uniform increments of travel, and a drive appropriate to effect such conveyor translation is illustrated as associated with and to act through the shaft 18. As shown, the conveyor drive is constituted as a toothed ratchet wheel 29 fixed to one end of the shaft 18, a link 30 carrying a ratchet detent 31 revolubly engaged at one end with the shaft 18 end to overlie the wheel 29 and dispose said detent 31 in customary coacting relation with the toothed periphery of said wheel, a shaft 32 journaled for rotation in spaced parallelism with and beneath the shaft 18 in driven relation with a prime mover, such as an electric motor 33, a crank arm 34 fixed to and rotatable with one end of said shaft 32, and a rigid pitman 35 hingedly interlinking the free ends of the link 30 and crank arm 34 for oscillation of said link 30 through an arc of appropriate extent in reaction to each revolution of the shaft 32 and its crank arm 34 and to consequently advance the wheel 29, shaft 18, and conveyor 25 as the detent 31 latches with said wheel 29 during one directional phase of link 30 oscillation; the elements comprised in the so-constituted drive being proportioned and interrelated to advance the conveyor 25 upper run a uniform, desired distance toward its higher end at each revolution of the shaft 32 and to permit said conveyor to remain at rest during alternate intervals each approximating one-half the time of shaft 32 revolution.

Development of a continuous "green sand" mold drag portion on and for travel with the upper run of the conveyor 25 is initiated at the lower end of said conveyor through the agency of a sand slinger 36, or equivalent device, supported in fixed relation with the frame 15 and appropriately powered, as by means of a driven shaft 37, for delivery of prepared molding sand fed thereto, conveniently through a hopper 38, as a moderately-compacted bed 39 covering the area of the conveyor exposed between frame-fixed side boards 40 upstanding at opposite sides of the slinger discharge and along the long margins of the conveyor at the lower end thereof. Obviously, the output capacity of the slinger 36 is correlated with the rate of conveyor travel to provide a sand bed 39 of substantially uniform, desired depth on the conveyor upper run, and such correlation may be accomplished through a regularly-intermittent drive of the shaft 37 synchronized with the intermittent conveyor drive, or, perhaps more expediently, through uniform drive of the shaft 37 at a speed appropriate for desired averaged output of molding sand and the provision of a strickle 41, or levelling board, bridging transversely of the conveyor between inner ends of the side boards 40 with its lower margin spaced upwardly from the conveyor upper surface a distance determinative of the desired sand bed depth, so that, while the slinger 36 continues to deliver sand to the conveyor between the boards 40 while the conveyor is at rest, the strickle 41 levels off the accumulated sand as the conveyor and its sand bed 39 moves thereunder and thus averages, or distributes, the slinger output in a sand bed of uniform depth longitudinally of the conveyor.

A feature of the invention is the compacting and patterning of the sand bed 39 associated with the conveyor 25 as a succession of mold drag sections conditioned for use, and in the illustrated apparatus organization such compacting and patterning is the function of a die-block 42 altitudinally power-reciprocable above and relative to the conveyor upper run just forwardly in the direction of upper run travel from the zone of sand bed deposition. As shown, an upward extension of the frame 15 sides just forwardly of the side boards 40 and strickle 41 includes fixedly-related members 43 spacedly above and disposed to span transversely across the conveyor 25 in fixedly-supporting relation with the cylinder 44 of an hydraulic or pneumatic ram assembly thus mounted with its axis perpendicular to the plane of the conveyor upper run and preferably in registration with the longitudinal median line thereof. Conveniently associated with and for extension and retraction axially and through the lower end of the cylinder 44, a stem 45 engages at one end with a piston 46 interiorly of the cylinder and at its other end with the die-block 42 in an arrangement effective to disposed said die-block between the lower end of the cylinder 44 and the upper run of the conveyor 25 for travel toward and away from said conveyor in reaction to shift of the piston 46 axially of the cylinder in a manner and structural organization typical of conventional ram assemblies. The under face of the die-block 42 is, in general, a smooth plane paralleling the conveyor upper run and is interrupted by patterning die elements 47 outstanding therefrom in any appropriate number, shape, and particular arrangement suitable for the development of mold impressions in the face of the sand bed 39 when the die-block is lowered into engagement therewith, the die elements illustrated being hemispherical for the development of ball-casting impressions. The die-block 42 is adapted to span laterally of the sand bed 39 and is preferably formed with skirts 48 depending from its margins overhanging the sides of the conveyor 25 in an upwardly-convergent sloping of their inner faces effective to laterally compact the sand bed engaged by the die-block and to facilitate separation of the said skirts from the sand bed when the die-block is elevated therefrom, and shallow lips 49 preferably outstand below and taper downwardly from the die-block 42 margins transverse to the conveyor to laterally indent and mark the sand bed 39 at each registration of the die-block therewith.

The regularly-intermittent drive of the conveyor 25 is designed to advance the conveyor upper run at each phase of its travel a uniform distance equal to the span of the die-block 42 face longitudinally of the conveyor, thus to reflect cyclic actuation of the die-block as a consecutive series of juxtaposed patterned impressions on the sand bed 39 translated thereunder, and said drive provides an interval of rest between successive phases of conveyor travel during which the die-block may be actuated by the ram assembly to compact and impress the sand bed area momentarily at rest therebeneath through the agency of controls operatively correlated with and responsive to the conveyor drive. Typical of means for effecting automatic, cyclic actuation of the

ram assembly and associated die-block 42 in appropriate synchronism with the conveyor drive, an air pressure system is represented as including a low pressure tank or reservoir 50 and a high pressure tank or reservoir 51 both served by a pump or compressor 52 through lines and facilities appropriate to maintain desired pressures therein, all in accord with well-known and conventional practice. From the low pressure reservoir 50 a line 53 leads to a spool-type valve assembly 54 which is in turn connected with the cylinder 44 to deliver beneath the piston 46 thereof by means of a line 55, and from the high pressure reservoir 51 a line 56 leads to a second spool-type valve assembly 57 which is in turn connected with the cylinder 44 to deliver above the piston 46 thereof by means of a line 58. The valve assemblies 54 and 57 are conveniently alike in a construction including a shiftable element whereof an axial stem, respectively designated 54′ and 57′, extends exteriorly of the valve body and is spring-loaded to yieldably hold the associated element at the spring-adjacent limit of its shiftable range, and said valve assemblies are secured in a suitable mount 59 fixed relative to the frame 15 with the axes of their stems 54′ and 57′ spacedly parallel and in a plane containing the axis of a shaft 60 journalled in said mount 59 in spaced parallelism with the powered shaft 32 and spacedly adjacent the free ends of said stems. A gear train 61 engages between the shafts 32 and 60 to rotatively drive said shaft 60 at the same speed and in the same direction as the shaft 32 when the latter is power rotated, and cams 62 and 63 are fixed in spaced relation to and for rotation with the shaft 60 in position for peripheral coaction with followers on the free ends of the stems 54′ and 57′, respectively. The supply lines 53 and 56 from the pressure reservoirs similarly connect with and near the centers of the valve assemblies 54 and 57 which they respectively serve, the lines 55 and 58 from the valve assemblies to the cylinder 44 similarly connect with their respective assemblies and toward the ends thereof away from the extending stems 54′ and 57′, each of the said valve assemblies is furnished with an exhaust to atmosphere, 64, opening therefrom near the assembly end characterized by the shiftable element stem, and the shiftable elements of the valves are arranged to establish communication between the pressure supply line and the cylinder serving line of the associated assembly when at one limit of their shift range and to establish communication between the cylinder serving line and the exhaust to atmosphere of the associated assembly when at the other limit of such range, the spring loading of the valve assembly stem being such as to urge the said shiftable elements of both valve assemblies to positions wherein the cylinder serving lines are in communication with the exhausts 64 of their assemblies. Quite manifestly, when the high pressure supply line 56 communicates through the valve assembly 57 with the line 58 serving the cylinder 44 above the piston 46 and the line 55 serving said cylinder below said piston communicates through the valve 54 with the exhaust 64 thereof the pressure system is conditioned for flow effective to lower the die-block 42 into compacting and patterning engagement with the underlying area of the sand bed 39, while, conversely, reversal of the valve shiftable element positions to place the line 58 in communication through the valve 57 with the exhaust 64 thereof and to establish communication through the valve 54 between the lines 53 and 55 operates to condition the system for pressure flow therein effective to elevate the said die-block away from the sand bed. Since the die-block 42 should be elevated and held out of engagement with the sand bed 39 during the recurrent phases of conveyor travel and should be actuated into and away from engagement with said sand bed during the intervals of conveyor rest, and since the spring loading of the shiftable valve elements as illustrated is arranged to yieldably maintain said elements at that limit of their travel range wherein communication is established between the exhaust 64 and cylinder serving line of the associated valve, the cam 62 is peripherally contoured and angularly related with the shaft 60 to shift the stem 54′ and its associated valve element inwardly of the valve 54 against the spring loading of the stem to the position, represented in Figure 11, wherein communication is established through said valve between the lines 53 and 55 and to hold the valve stem and element in such position during that portion of shaft 60 revolution, approximating one hundred and eighty degrees, through which the drive operated by the shaft 32 is effective to move the conveyor; the contour of said cam 62 accommodating spring return of said stem 54′ and associated valve element to the position of flow communication between the line 55 and exhaust 64 of the valve 54 during the remaining portion of shaft 60 revolution corresponding with the conveyor rest phase of shaft 32 rotation. Correlating the action of the valve 57 with and in substantial opposition to that of the valve 54, the cam 63 is peripherally contoured and angularly related with the shaft 60 to permit the spring loading the stem 57′ to hold said stem and the associated valve element in a position of flow communication between the line 58 and exhaust 64 of the valve 57 during the time that the lines 53 and 55 are in flow communication through the valve 54 and in the relationship represented by Figure 11, thus to provide for maintained elevation of the die-block 42 throughout the conveyor-moving phase of drive operation, and the contour of said cam 63 includes a radially-extended lobe of moderate angular extent disposed to shift the stem 57′ and its associated valve element against the spring loading of said stem and to a position accommodative of flow between the lines 56 and 58, and to permit return of said stem and valve element to the position from which shifted, during the approximate half-revolution of the shaft 60 corresponding with the conveyor rest interval of the drive, thus to impel the die-block 42 into operative engagement against the sand bed 39 while the conveyor is at rest and the valve 54 is conditioned to open an exhaust passage from the cylinder 44 chamber below the piston 46. Arranged as shown and described, the drive represented by the shaft 32 is effective through the shaft 60, cams 62 and 63, and valves 54 and 57 to automatically correlate ram assembly actuation with the regularly-intermittent conveyor travel for the development of a contiguous series of die-block 42 impressions successively imposed upon the sand bed 39 during the intervals of conveyor rest.

The mold drag sections developed in the sand bed 39 by means of the die-block 42 move with the upper run of the conveyor 25 in a step-by-step progress to and past a platform, or station, 65 where pre-formed mold cope sections 66 are successively applied by an operator to complete a continuous mold organization ready for charging with molten metal. The mold cope sections 66 may be pre-formed, transported to the station 65, and applied to and in registration with the drag sections at said station in any convenient manner and by any suitable means, it being feasible to suspend the individual cope sections by means of toggles 67 from an overhead track along which said sections are moved into successive side registration against a guide board 68 transversely and perpendicularly bridging the conveyor 25 in position to direct the cope section 66 as it is lowered to an appropriate mating with its complementary drag section. The transverse markings of the sand bed 39 produced by the lips 49 of the die-block 42 facilitate appropriate registration of the cope sections 66 with the sand bed drag sections and may be variously utilized for such purpose, as will be obvious, and the said cope sections 66 may be retained within, or released from their usual forming flasks when and as assembled with the drag sections, all of which is well

within the scope of known and established practice, but because of the charging technique distinguishing the invention any flasks retained on the assembled cope sections must be of metal. A significant feature manifest in the cope sections **66** is the provision of a charging trough component in the form of a channel **69** bisecting and extending entirely across the upper surface of each said section in position for end registration with the like channels **69** of adjacent sections as a continuous flow trough longitudinally of the cope section assembly upper surface, the gates and sprues of the individual cope sections **66** being arranged in communication with and to feed the mold cavities from the channel **69** of the said section. As the cope sections **66** are successively registered with their complementary drag sections and juxtaposed in alignment of their channels **69**, the operator fills and plugs any open spaces separating said sections to complete a flow or charging channel longitudinally of the conveyor-supported mold assembly and across the several sections thereof at such inclination to the horizontal as will conduce to flow of molten metal therein and away from the drive end of the assembly.

Molten metal for charging of the completed mold assemblies is fed as a continuous stream to the flow trough constituted from the channels **69** at a point between the station **65** and drive end of the conveyor, conveniently through the agency of a ladle **70** adapted to repetitiously charge a pouring basin **71** appropriately supported and positioned above the conveyor for delivery to said trough, and the supply of molten metal to said trough is so regulated and proportioned to the rate of conveyor travel as to establish a point of its inflow into the molds at some distance from the said basin **71** in a direction away from the conveyor drive end and to maintain a stream of molten metal, indicated at **72** in Figure 1, in the flow trough between the basin **71** and point of metal inflow to the molds whereunder the fully-charged molds pass with advantage of gas escape and filling of shrinkage cavities during initial cooling and solidifying stages of their charges.

The conveyor **25** extends beyond the pouring basin **71** a distance so proportioned to the rate of conveyor travel as to permit adequate solidification of the mold assembly charges before the said assemblies successively reach and break over the drive, or higher, end of the conveyor where the return of the conveyor about the sprockets **19** acts to disrupt the sand bed and cope mold sections and to deliver the material of said sections, together with the solidified mold charges, to means, such as a conveyor **73**, for the subsequent handling, separation, and processing of the conveyor discharge.

Since changes, variations, and modifications in the form, construction, and arrangement of the elements shown and described may be had without departing from the spirit of my invention, I wish to be understood as being limited solely by the scope of the appended claims, rather than by any details of the illustrative showing and foregoing description.

I claim as my invention:

1. Means for the continuous casting of metal in green-sand molds, comprising a flat conveyor driven for uniformly-intermittent translation along an upwardly-inclined path, means operable in correlation with said conveyor for the development of a continuous loose sand bed upon and for travel with the conveyor, means operatively synchronized with the conveyor travel for the repetitiously successive mold impression and compaction of said bed, a plurality of preformed mold cope sections registrable with and to close over the mold impressions of the bed, means for successively correlating said cope sections in end-abutting sequence on and for travel with said conveyor and in registration with the mold impressions of the sand bed, and means for charging the so-completed mold units with molten metal while moving with said conveyor.

2. The organization according to claim 1, wherein the means for the development of a continuous loose sand bed upon the conveyor comprises a sand slinger operatively associated with and for deposition of its output upon the lower end of said conveyor, guide boards determinative of sand bed width upstanding in spaced parallelism above side margins of said conveyor, and a strickle determinative of sand bed depth spacedly above and laterally bridging said conveyor between the guide board ends leading in the direction of conveyor travel.

3. The organization according to claim 1, wherein the means for mold impression and compaction of the loose sand bed on the conveyor comprises a frame bridging across the conveyor inwardly adjacent its lower end, a die-block altitudinally reciprocable in said frame into and out of engagement with the sand bed upper surface, impression dies on the under face of said die-block, downwardly-diverging skirts on said die-block aligned with margins of said conveyor for compacting engagement with the sand bed sides, and means for automatically reciprocating said die-block at each interval of conveyor rest.

4. The organization according to claim 1, wherein the preformed mold cope sections are alike in a proportion longitudinally of the conveyor corresponding to the spacing between successive like mold impression points of the sand bed and are characterized by channel interruptions of their upper surfaces alignable as a trough longitudinally of the conveyor.

5. The organization according to claim 1, wherein the means for correlating the cope sections with the conveyor in registration with the mold impressions of the sand bed comprises scorings developed transversely of the sand bed at the ends and as an incident of each mold impression and a guide member fixedly spanning the conveyor for registration with successive rest positions of said scorings adapted for position-determining engagement by successive cope sections.

6. The organization according to claim 1, wherein the means for charging the completed mold units with molten metal comprises a trough longitudinally of the cope section assembly upper surface serving the successive cope section gates and pitched as a consequence of conveyor inclination for gravity-induced flow therein opposed to the direction of conveyor travel, and a pouring basin delivering to said trough adjacent the higher end thereof; whereby to provide for charging of the advancing mold units well prior to their individual transit beneath said basin and at the lower end of a molten metal stream maintained in said trough.

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