Sept. 2, 1969 H. F. HARTZELL, JR 3,464,481

BILLET AND SLAB TRANSFER DEVICE

Filed Aug. 15, 1967 5 Sheets-Sheet 1

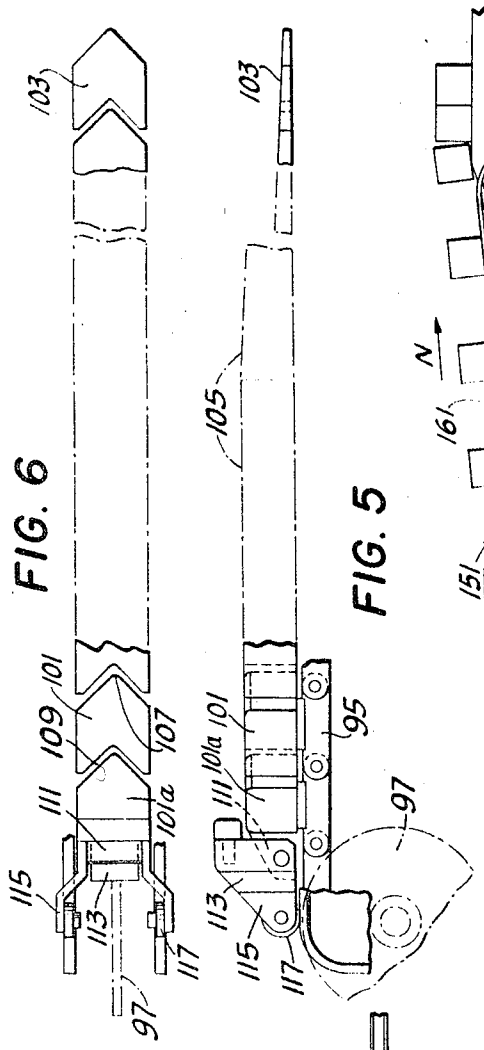


FIG. 6

FIG. 5

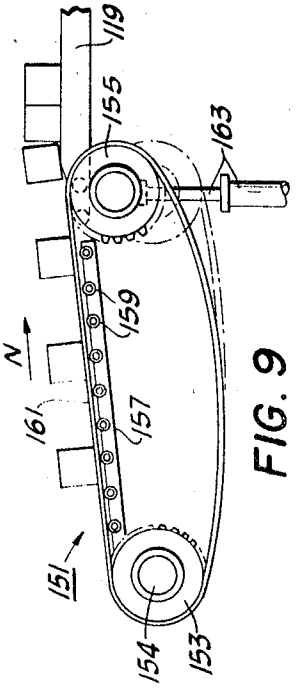


FIG. 9

FIG. 1

INVENTOR.
HARRY F. HARTZELL, Jr.
BY Sherman H. Barber
his Attorney

Sept. 2, 1969 H. F. HARTZELL, JR 3,464,481

BILLET AND SLAB TRANSFER DEVICE

Filed Aug. 15, 1967 5 Sheets-Sheet 2

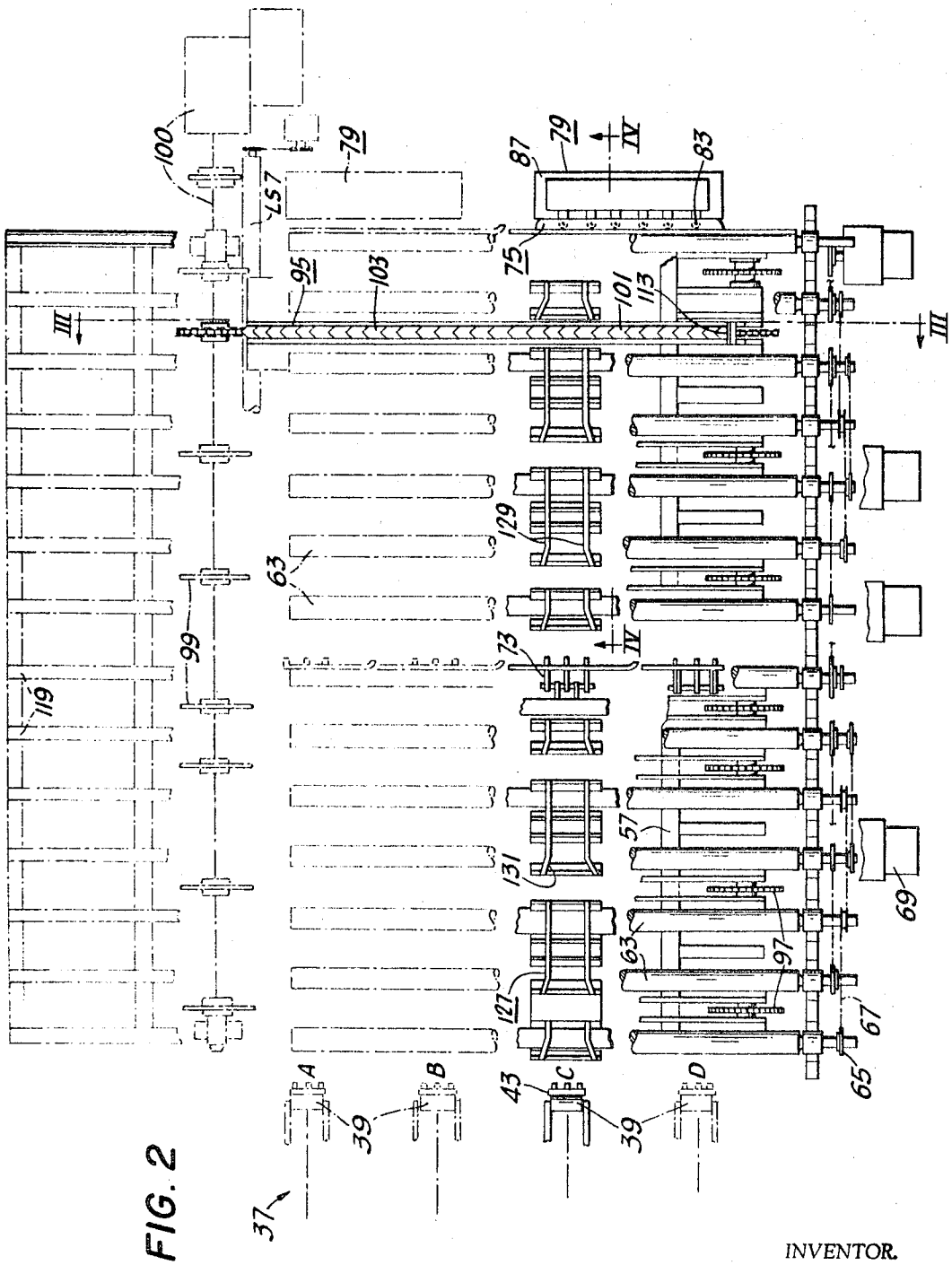


FIG. 2

INVENTOR.
HARRY F. HARTZELL, Jr.
BY Sherman & Barber
his Attorney

Sept. 2, 1969 H. F. HARTZELL, JR 3,464,481

BILLET AND SLAB TRANSFER DEVICE

Filed Aug. 15, 1967 5 Sheets-Sheet 3

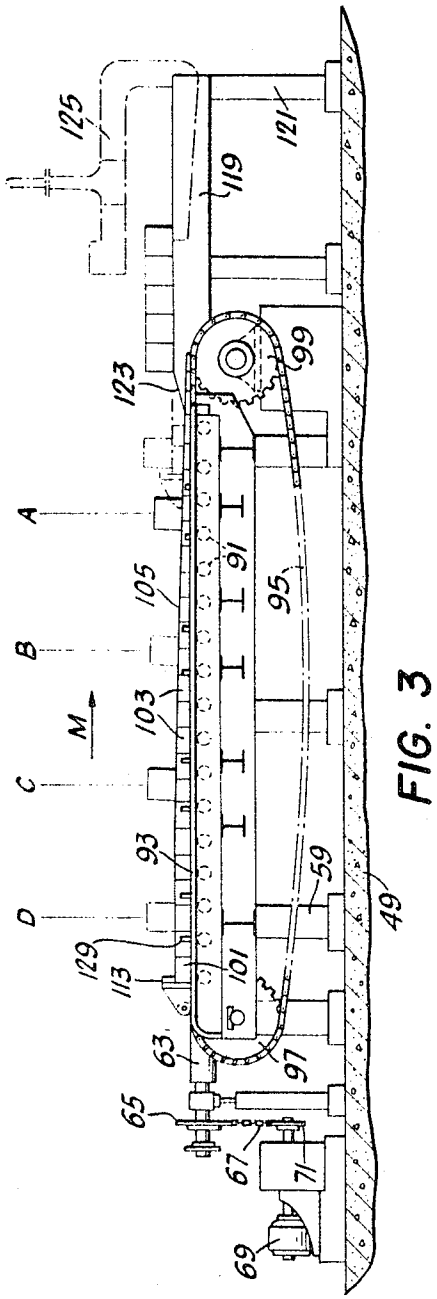


FIG. 3

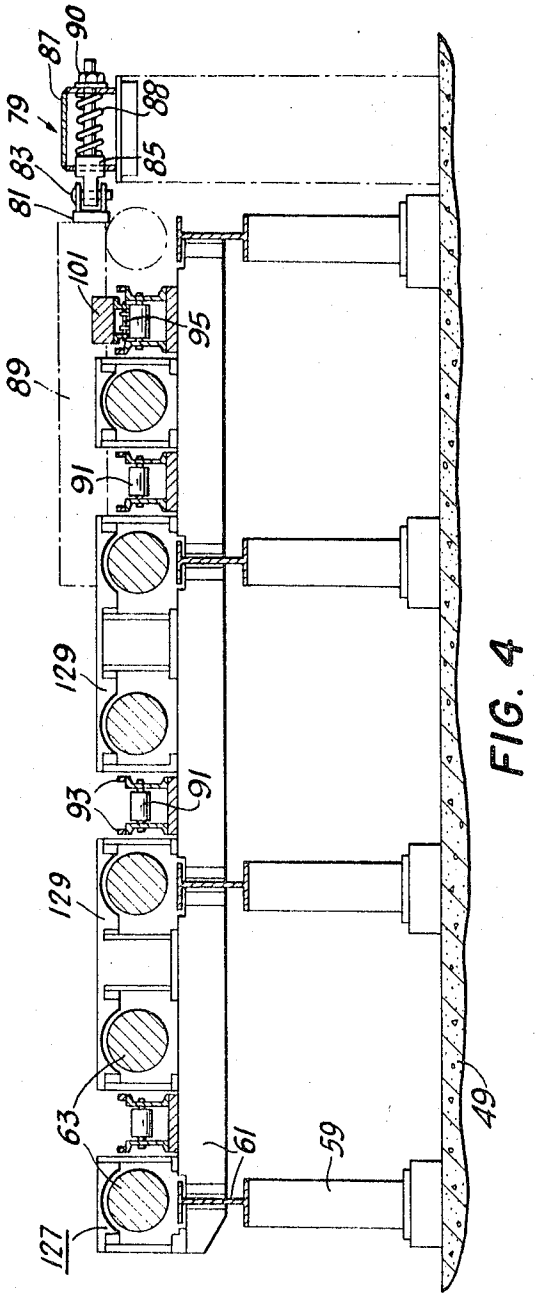


FIG. 4

INVENTOR.
HARRY F. HARTZELL, Jr.
BY Sherman & Barber
his Attorney

Sept. 2, 1969 H. F. HARTZELL, JR 3,464,481

BILLET AND SLAB TRANSFER DEVICE

Filed Aug. 15, 1967 5 Sheets-Sheet 4

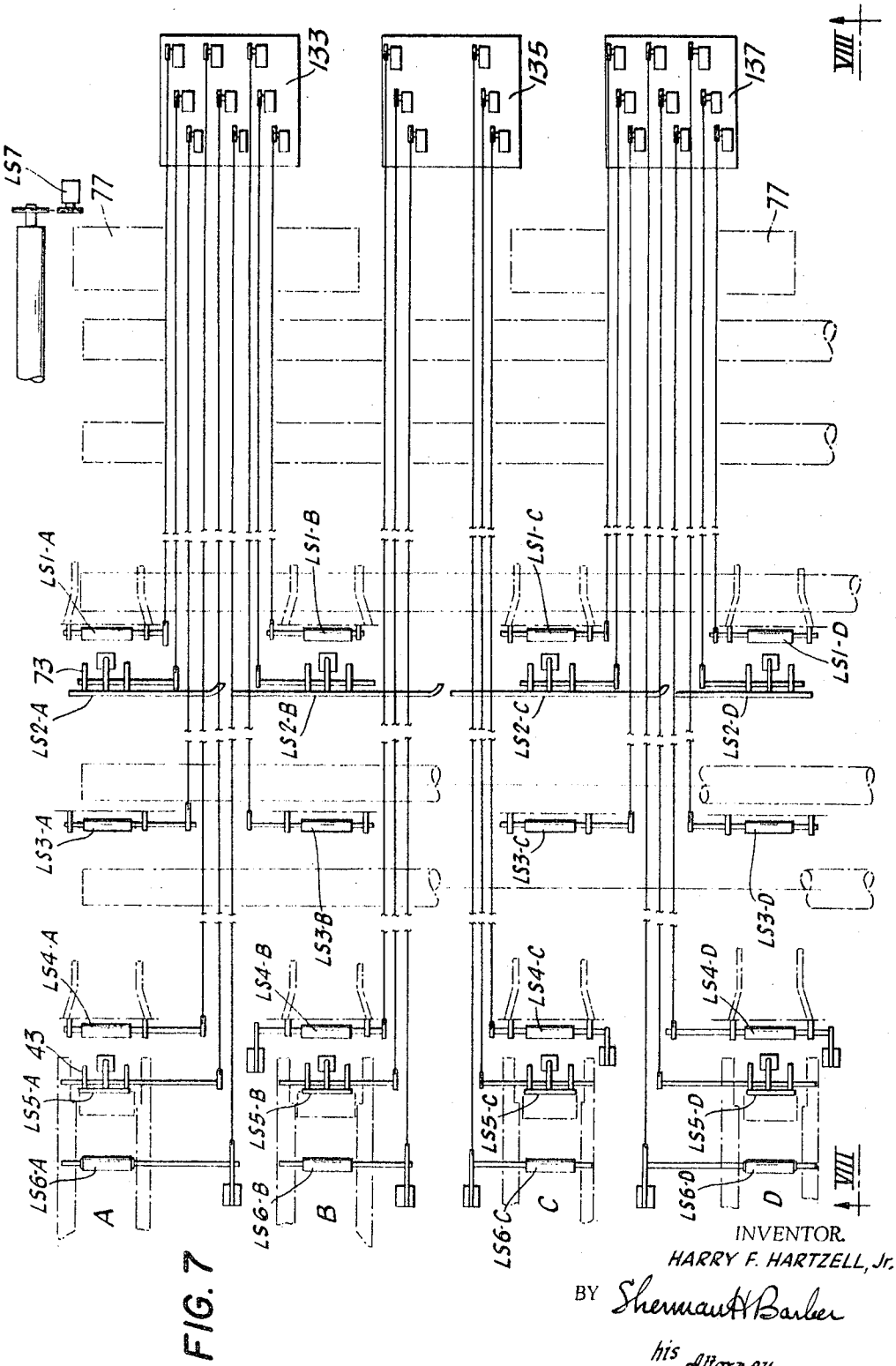


FIG. 7

INVENTOR.
HARRY F. HARTZELL, Jr.
BY Sherman & Barber
his Attorney

Sept. 2, 1969 H. F. HARTZELL, JR 3,464,481

BILLET AND SLAB TRANSFER DEVICE

Filed Aug. 15, 1967 5 Sheets-Sheet 5

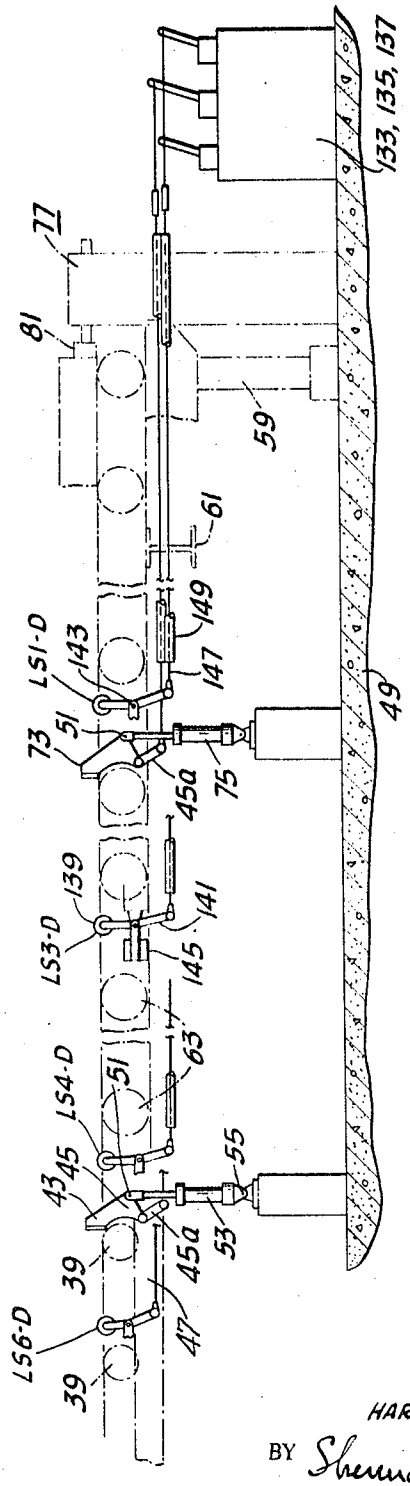


FIG. 8

INVENTOR.
HARRY F. HARTZELL, Jr.
BY Sherman H. Barker
his Attorney

United States Patent Office 3,464,481 Patented Sept. 2, 1969

3,464,481

BILLET AND SLAB TRANSFER DEVICE

Harry F. Hartzell, Jr., Allison Park, Pa., assignor to Koppers Company, Inc., a corporation of Delaware

Filed Aug. 15, 1967, Ser. No. 660,813
Int. Cl. B22d *11/12, 11/14;* B65g *47/29*
U.S. Cl. 164—269 11 Claims

ABSTRACT OF THE DISCLOSURE

Billets and slabs that are cut from horizontally extending continuous cast strands move under control of automatically operated stops in sequence onto a transfer device including a plurality of spaced apart horizontally arranged powered rollers. Endless chains located between adjacent rollers have slab or billet engaging blocks mounted to individual links of the chain that form a long articulate wedge; the blocks progress upwardly in height incrementally from link to link over a finite length of chain. When the billets or slabs move onto the transfer device, they actuate limit switches and the wedge device mounted to the chains move at right angles to the direction of movement of the billets or slabs. The billets or slabs are both raised by the wedge shaped blocks and transferred by the chains to a gathering platform from which several billets or slabs are removed at one time.

BACKGROUND OF THE INVENTION

In continuous casting machines, such as the low-head or curved mold type, or other type of machine where the billet or slab is discharged horizontally, the cast strand or slab passes a cut-off mechanism and billets or slabs of convenient lengths are severed from the continuous strand of metal. In such casting machines, there is a problem of arranging and stacking the billets or slabs after they leave the cut-off station. A principal difficulty is moving billets or slabs across one or more adjacent strand paths. Heretofore, in some types of continuous casting machines, each billet path has been of a finite length and the lengths of the billet paths vary incrementally to allow easy transfer in the same plane of all of the billets. The length of the longest billet path then is equal to the length of the longest billet to be handled times the number of strands being produced simultaneously. In practice, this means that the run-out table of a six strand machine, for example, may be over one hundred twenty feet in length, where twenty foot billets are being produced. But, such a long run-out table or tables require a considerable amount of area and is a costly facility to install.

SUMMARY OF THE INVENTION

In accordance with the invention, billets or slabs move onto a transfer device along guide paths determined by fixed side rails. The billets or slabs move on horizontal rollers, and between the rollers there are endless chains moving at a right angle to the axis of the billets or slabs. Each chain comprises a plurality of wedge shaped blocks forming an articulated elongated tapered wedge which, upon a signal being given, moves under the billets or slabs and raises them off of the rollers on which the billet or slab rests. The chains move simultaneously at right angles to the direction of movement of the billets or slabs and transport the billets to a gathering device from which a plurality of stacked billets may be periodically removed. The invention may be used also to deliver billets or slabs in an orderly sequence to cooling bed stackers, edge grinders, or other machinery for further processing.

For a further understanding of the invention and for advantages and features thereof, reference may be made to the following description in conjunction with the accompanying drawings which show, for purposes of exemplification, embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a schematic elevational view of a typical continuous casting apparatus;

FIG. 2 is a plan view of the transfer portion of the apparatus of FIG. 1 in accordance with the invention;

FIG. 3 is a sectional view along line III—III of FIG. 2;

FIG. 4 is a sectional view along line IV—IV of FIG. 2;

FIG. 5 is an elevational view of a portion of the transfer chain;

FIG. 6 is a plan view of the chain of FIG. 5;

FIG. 7 is a schematic plan view of the control mechanism associated with the apparatus of FIG. 2;

FIG. 8 is a view along line VIII—VIII of FIG. 7; and

FIG. 9 is a schematic modification of the device of FIG. 2.

DETAILED DESCRIPTION

The novel transfer apparatus designated generally **41** is illustrated in FIG. 1 as cooperating with a continuous casting machine **11** of the multi-strand type. Cutting torches **35**, or other suitable apparatus, sever a plurality of horizontal continuous strands **24** of metal discharging from the multi-strand continuous casting machine **11** into incremental units of predetermined lengths. A transfer device **41**, FIG. 2, for receiving and transferring these incremental units includes: a frame **57** to which a plurality of spaced apart and power driven rollers **63** are mounted to support the incremental units **89** and move the units in a first direction that is generally the direction of the horizontal travel of the units from the continuous casting machine **11**.

A plurality of spaced apart guide means **129** are mounted on the frame **57** to define spaced apart paths along which the incremental units **89** move in this first direction. As the units move along the paths, they contact a first unit arresting means **79** that is disposed at a location along each path to arrest an incremental unit moving along the path. Since the strands **24** are being continuously formed and cut into incremental units, a second unit arresting means **73** is movable into each of the paths to prevent a second incremental unit from occupying the portion of a respective path occupied by a first unit.

Third means **95** is located in the space between adjacent unit supporting rollers **63** and is movable so as to lift the incremental units **89** off of the rollers **63** for transporting the units in a second direction that is generally at a right angle to the first direction.

Fourth means is provided for actuating the third means whereby the third means moves and transfers the raised incremental units supported thereon in the second direction.

A fifth means **119** is provided for removing the incremental units from the third means.

Furthermore, the transfer device **41** includes: first switch means associated with each path and actuated by an incremental unit; means acting responsively to the first switch means to move the first unit arresting means into the path; second switch means associated with each path and actuated by an incremental unit; means acting responsively to the second switch means to move the second unit arresting means into the path behind the first unit; and means actuated by the third means to move the first and second unit arresting means out of the path when the incremental unit has been removed from the third means whereby additional incremental units move onto the apparatus.

A known type of multi-strand continuous casting ma-

chine 11, illustrated in FIG. 1, includes a ladle 13, a tundish transfer car 15 that supports a tundish 17, a vertically oscillatable continuous casting mold 19, spray chambers 21 located directly below the molds 19, heat shields 23 surrounding the cast strands 24 and extending between the spray chambers 21, and sets of pinch rolls 23 for use in withdrawing the cast strands 24 from the molds 19. As will be noticed from FIG. 1, the tundish transfer car 15 is mounted on rails so that it can be moved laterally away from the position shown in FIG. 1, directly above the molds 19, and the several elements 19, 21, 23, and 25, are vertically in line and vertically spaced apart.

As the cast strands 24 leave the pinch rolls 25, hydraulically operated bender roll mechanisms 27 engage the strands and change the direction of the strands from vertical, as they are above the pinch rolls 25, toward the horizontal direction as they pass through straightener rolls 29. Between the bender roll mechanisms 27 and the straightener rolls 29, the strands 24 pass first through strand guides 31 and then onto apron structures 33 situated just before the straightener rolls 29.

After the strands 24 pass through the straightener rolls 29, they pass a torch cutting mechanism 35 or other suitable device that severs the strands into billets or slabs of desired length. Thereafter, the incremental units, which may be individual billets or slabs, move onto conventional run-out tables 37.

In the following detailed description, the continuous casting machine is a multi-strand unit that produces simultaneously four strands; the strands that travel along separate paths hereinafter designated A, B, C, and D.

Associated with the multi-strand continuous casting facility 11 is a run-out table 37 including powered rollers 39 that support and transport the four slabs or billets simultaneously. The run-out table 37 (shown at the left of FIG. 2) has four separate paths, A, B, C, and D, of equal lengths, along which the billets or slabs move from left to right toward a billet or slab transfer device 41 in accordance with the invention. In FIG. 2, the structure associated with billet feed path C of the transfer device 41 is shown in solid lines, as representative of the structure associated with the other paths, which are shown only schematically or not at all, for the sake of simplification and clarity in the drawing.

At the end of the billet feed path C on the run-out table 37, there is a billet stop device 43, which is shown in FIG. 8. The billet stop device 43 comprises an arm 45 that is pivotally mounted to a support 47 located below the last powered roller 39 of the run-out table 37, and that is fixed to the ground or to other foundation structure. The arm 45 is pivotally connected at 51 to a cylinder-piston apparatus 53 that is also pivotally connected at 55 to the support structure 49. The cylinder-piston 53 operates, in the manner described hereinafter, to pivot the arm 45 upward (as shown by the solid outline), in which position it intercepts and prevents billets or slabs from moving onto the transfer device 41.

The transfer device 41, which not only receives and transfers incremental units, but also accumulates them in ordered groups from the variable discharge of the continuous casting machine, comprises a fixed frame structure 57, including spaced apart upright column members 59 supported on the ground 49 and interconnected horizontal support girders 61 that forms a grid structure on which are mounted a plurality of elongate horizontal powered rollers 63. The rollers 63 are journalled in the frame 57 and each roller 63 is provided with sprockets 65 at one end. Several roller sprockets 65 as a gang coact with a drive chain 67 powered by a motor 69 and a drive sprocket 71. A plurality of such motor-sprocket-chain drives powers all of the rollers 63 so that billets or slabs moving onto the transfer device 41 advance along each path A, B, C, and D, toward another stop 73 located midway along the length of the transfer device 41.

The stop 73 is similar to the stop 43, and it is pivotally connected to a cylinder-piston 75 which is similar to the cylinder-piston 53 shown in FIG. 8.

At the right-hand edge of the transfer device 41 (FIG. 2) there are two billet energy-absorbing mechanisms 79, which are also shown in FIG. 4. Each billet energy-absorbing mechanism 79 comprises a horizontal shoe 81 that is mounted by pins 83 to plungers 85 extending into and through a housing 87. Within the housing 87 are a plurality of springs 88 that surround respective plungers 85 and which absorb the impact load of a billet or slab 89 advancing to and engaging the shoe 81. The plunger 85 extends through the housing 87 and a nut 90 is threaded on the plunger to allow for adjustment of the compression of the spring 88. Though not shown, similar resilient energy absorbing devices would be provided on the impact faces of the stop devices 43 and 73.

There are a plurality of spaced apart other rollers 91 located between pairs of adjacent rollers 63, as shown in FIGS. 2 and 4, that are removably journalled in rails 93 fixed to the horizontal girders 61. Preferably, the rollers 91 are so journalled that each roller may be removed, and a replacement roller may be installed, without removing or disturbing the fixed rails 93. In the embodiment of the invention shown in FIGS. 2 and 3, all of the rollers 91 are arranged at the same horizontal level above the top of the frame structure 57. Other embodiments de-described later herein disclose modifications in the arrangement and location of these rollers 91.

The rollers 91 support an endless chain 95 which surrounds sprockets 97, 99 disposed at opposite sides of the transfer device 41. The sprockets 99 are driven simultaneously by a suitable motor and shafting arrangement 100. To each one of a plurality of adjacent chain links is secured a billet supporting block of metal 101, 103, as shown in FIGS. 2, 3, and 5, 6. It should be noticed that the billet supporting blocks 101 are of substantially the same thickness; that is, the top of the blocks 101 are at the same horizontal level above the girders 61. The billet supporting blocks 103, however, are of differing thickness, and each block 103 has a trapezoidal cross sectional shape. Thus, the top surfaces of adjacent blocks 103, when viewed together, form an articulated elongate tapered wedge surface 105, extending generally from sprocket 99 to sprocket 97.

All of the individual blocks 101, 103 except the lift-hand end block 101*a* (FIGS. 5, 6) have a pointed end 107 and a corresponding V-shaped vertical groove 109 in the opposite end. The pointed end 107 of one block is positioned in the V-shaped groove 109 of the next adjacent block, thereby providing longitudianl continuity of contact surface with the billets or slabs.

The end block 101*a*, however, has no V-shaped groove, but it has an outward projection 111 to which is pivotally mounted a billet pusher block 113. The billet pusher block 113 has a pair of arms 115 to which are mounted wheels 117 that engage and roll on fixed rails 93. The fixed rails 93 extend horizontally only between the sprockets 97, 99. The wheels 117, which engage the rails 93, maintain the billet pusher block 113 in the operative upright position, shown in FIG. 3, as the billet pusher block 113 passes over the chain sprocket 97. When the billet pusher block 113 passes over the sprocket 99 and the wheels 117 are no longer in contact with the fixed rails 93, the billet pusher block 113 pivots downwardly in a counterclockwise direction below the level of the top of the blocks 101. As long as the wheels 117 contact the rails 93 the billet pusher block stands in the upright position and engages the side of billets or slabs and moves them from left to right, as indicated in FIG. 3, off of the transfer device 41.

FIGS. 2 and 3 illustrate an arrangement of spaced apart skid rails 119 that are fixed in a location at one side of the transfer device 41. The skid rails 119 are supported on columns 121 firmly anchored to the ground or foundation 49, and the end of each skid rail adjacent the transfer

device **41** is tapered, as at **123**. The tapered end portion **123** aids the movement of the billets or slabs **89** from the tapered wedge surface **105** onto the horizontal portion of the skid rails **119**, where the billets **89** from which the billets or slabs may be removed by other apparatus such as a conventional C-hook **125**, a fork-lift truck, an automatic stacking device, or other similar device.

FIG. 7 is a plan view of the automatic controls for the transfer device **41** shown in FIGS. 2 and 3. As mentioned previously, the continuous casting machine **11** is a four strand machine, and the transfer device **41** is adapted to handle four billets or slabs moving simultaneously along paths A, B, C, and D. Since the mechanism associated with each path of billet travel is the same, only the controls associated with path C are described herein. It is to be understood, however, that the controls associated with billet travel paths A, B, and D are substantially identical to those of path C.

The billet transfer apparatus **41** is adapted to handle billets or slabs of different sizes and lengths. In a first description of the operation of the apparatus, the billets **89** are 4" x 4" and 10 feet long; in a second description the billets **89** are 4" x 4" and 5 feet long; and in a third description the description the billets **89** are 4" x 4" and 30 feet long. All of the operating descriptions are representative of the procedure for handling billets or slabs of other different sizes and lengths.

After a 4" x 4" x 10 ft. billet **89** is severed from a continuous strand by the cut-off mechanism **35**, the billet **89** moves along the path C of the run-out table **35** toward the transfer device **41**. The billet **89** first enters a guideway **127** comprised of spaced apart parallel rails **129**. The rails **129**, as shown in FIG. 2, are arranged in increments, and each incremental length of rail is supported upon horizontal girders **61** (FIG. 4). The rails are incremental in length to afford access for the billet transfer chains **95** to move between the rollers **63** in a direction at right angles to the direction of the rails **129**. The entrance end **131** at each pair of spaced apart rails **129** preferably diverges slightly to provide easy guidance for a billet or slab into a particular incremental length of guideway **127**.

The billet **89** traveling in guideway **127** along path C, passes over and depresses in succession a plurality of rollers **139** and levers **141** in which the rollers are journalled; the movement of these levers actuates limit switches LS6–C, LS4–C, LS3–C, and LS1–C. The billet **89** proceeds along path C until the leading end of the billet contacts the shoe **81**; whereupon it stops. When trailing end of the billet **89** clears the roller and lever connected to the switch LS1–C, the arm **141** pivots and actuates one of the switches on switch box **137**. Then, a signal is transmitted to a solenoid valve (not shown) controlling the flow of fluid to cylinder-piston **75**, whereby the stop **73** in path C raises and moves into the vertical position shown in FIG. 8. Actually, all of the billet or incremental unit stops **73**, in guideways A, B, and D, also raise, unless another billet happens to be crossing the stop **73**, or is in the approach zone of the guideways along another path A, B, or D. This other billet would depress one of the LS1 series switches in its particular path, and such fact would be apparent on a central control panel (not shown) so that the billet stop **73** in the path of such other billet would not raise.

If the other billet should happen to be in the approach zone of guideway A, or should be crossing the billet stop **73**–A, say, it depresses limit switch LS3–A and the stop **73** of guideway A will not raise. After this particular billet clears limit switch LS1–A, however, the lever arm **141** pivots and the switch on support **133** operates to send a signal to the solenoid valve that controls the flow of fluid to the cylinder-piston arrangement **74** of the stop in guideway A. The stop **73** of path A will then pivot upwardly to the vertical position. In the right-hand portion of guideways A and C, all of the billet stops **73** are in the raised position.

It may be possible that a second billet is following close enough behind the first billet in guideway A so that limit switch LS4–A is also depressed. In this situation, the second billet moves along path A until it engages the raised stop **73**. When the second billet clears the limit switch LS4–A, this switch signals the solenoid valve (not shown) controlling fluid to the cylinder-piston arrangement **53** and the stop **43** of path A raises, thereby preventing a third billet in path A of the run-out table **37** from advancing onto the transfer device **41** along path A. The other stops **43** in paths B, C, and D also raise simultaneously unless a stop **43** is prevented from raising by a billet or slab moving along one of these paths that depresses actuator LS4. As soon as the actuator LS4 is released after the billet passes, the stop **43** in that path also raises.

At this particular point in the sequence of operation, we find first billets in the right-hand portions of guideways A and C, and a second billet in the left-hand portion of the guideway A only. The stops **43** and **73** of all paths A, B, C, and D, are raised so that no other billets may enter the transfer device **41**; and the second billet in guideway A cannot pass to the right-hand portion of the transfer device because of the raised stop **73**.

Now, after the second billet clears limit switch LS4–A, and after all of the stops **43** are raised, a signal is sent via the LS5 limit switches to a timer switch (not shown) which may be set at any predetermined time delay for the happening of some event; the event in this instance is the commencement of movement of the conveyor chains **95** after the passage of the predetermined time.

All of the conveyor chains **95** in FIG. 3 are in the billet-carrying position. Initially, the chains **95** start from a stop position with the thinnest carrying wedge located just to the left of the guidway bars **129** of path D, as seen in FIG. 3. From the initial position the chain conveyors **95** move in the direction of the arrow M (FIG. 3) toward the billets or slabs, and the blocks **101**, **103** engage the bottom of the billets **89**, thereby moving the billets laterally against the guideway bars **129** of the respective guideway. Continual movement of the wedge-shaped blocks **103**, against the resistance provided by the guideway bars **129**, causes the billet to raise vertically on the wedge-shape chain until the billet is raised sufficiently to clear the top of the guideway bars **129**. The height of the guideway bars **129** progressively increases from a lowest height at guideway A to a highest height at guideway D so that a space is created between adjacent billets and each billet is carried on the chain independently of the other billets. Thus, it is clear that one billet does not contact and push another billet as it is being raised above the guideway bars **129**. Once the billets have been raised sufficiently to clear the side of the guideway bars **129**, the billets then are carried on the wedge surface **105** toward the skid rails **119**. The billets first contact the tapered portion **123** of the skid rails, and are then urged up onto the horizontal portion of the skid rails by the billet pusher blocks **113** acting on the sides of the billets.

The chain conveyors **95**, as part of a cycle, proceed around the drive sprocket **99** and return to the initial position described hereinbefore where they stop. They have now completed the cycle. As mentioned previously, the billet pusher block **113** pivots downwardly as soon as the wheels **117** disengage from the fixed rails **93**, near the sprocket **97**, the pusher block **113** pivots upwardly again to its operative billet-carrying position, as shown in FIG. 3.

During the time the chain conveyors **95** are moving the raised billets toward the skid rails, and, actually, when the billets in paths A and C have been raised above the guideway bars **129**, the drive mechanism for the chain conveyors **95** also rotate an elongate cam limit switch LS7. The cams in switch LS7 are set so that, as soon as a billet is lifted free of the rolls **63**, a signal is sent to the solenoid valves (not shown) that control the flow of fluid

to cylinder-pistons **75** whereby the stops **73** in paths D through A lower successively in that order. Thus, there is no danger of a billet that is being transferred from engaging and possibly damaging a raised stop **73**.

After the billet pusher blocks **113** have cleared path A guideway bars, the cam LS7 signals the solenoid valves controlling the flow of fluid to cylinder-pistons **53** and all of the stops **43** are lowered and the transfer device **41** is ready to commence receiving billets and slabs in a repeat cycle. The cam limit switch LS7 signals the solenoid valves controlling fluid flow to the cylinder-pistons **53**, **75**, and, as a result, the billet stops **43**, **73** lower in all of the paths A, B, C, and D.

The foregoing describes the operation of the transfer device when handling billets that are 10 feet long. The following now describes the operation of the transfer device when handling billets that are only 5 feet long. In this instance, the limit switches LS3–A through D, are locked out of the system and are inoperative.

The continuous strands **24** are cut as before to form billets or slabs five feet long that travel along the run-out table and move onto the transfer device. Initially, all of the stops **43**, **73** are down so that the first billet or slab arrives at the energy absorbing stop **79** and comes to rest in a position with one end against the shoe **81**. If the first billet is traveling along path A, then, as soon as the billet clears the limit switch LS1–A, a signal is sent, as before, to the solenoid valve controlling the flow of fluid to the cylinder-piston **75**, and the stop **73**–A raises. The other stop **73**–B, **73**–C and **73**–D operate independently, and are raised when a billet clears the LS1 switch in the particular path B, C, D. The next billet in path A passes over and clears the LS4–A switch, and the stop **43**–A, and all other 43 stops then raise. This prevents movement of any more billets onto the transfer device **41**, unless a billet is at that particular moment crossing a **43** stop, as indicated by depressed LS4 switch, or unless a billet is in the approach area, as indicated by a depressed LS6 switch. In such case, the billet in the approach area moves onto the transfer device **41** as before. But, after the billet clears the LS4 switch, the **43** stop in the particular path raises so that no more billets can move onto the transfer device. After all 43 stops are raised, a signal is sent by the LS5 switches to the aforementioned timer switch, which has been reset to another preselected time interval. After the expiration of the preselected time interval, a signal is sent to the drive motor and shafting **100** and the chain conveyors **95** and wedge surface move toward the skid rails, raising and carrying the billets or slabs in the respective paths. The transfer of the billets from the wedge surface **105** to the skid rails **119** is done in the same manner as described hereinbefore.

When billets as long as 30 feet are handled by the transfer device, it should be apparent to those skilled in the art that the stops **73** are lowered, and the limit switches LS1–A through LS1–D, and LS2–A through LS2–D, and LS3–A, are locked out of the system. The operation of the remainder of the system is the same as that described hereinbefore; it being apparent that when the 30 foot billet clears the LS4 switches the stops **43** raise and prevent any more billets from entering the transfer device **41**. Thereafter, the wedge surfaces engage the 30 foot billets and move them onto the skid rails **119** in the manner described hereinbefore.

FIGS. 7 and 8 indicate how different limit switches are actuated by the billets in the manner disclosed. The limit switches are actually located in or on top of enclosures **133**, **135**, **137** that are located away from and along one side of the transfer device **41**. This is a desirable location because the switches are not then affected by heat radiating from the hot billets or slabs, nor are they affected by contact with any of the hot scale that may fall from the billets or slabs as they are being transferred over the rollers **63**. Typically, each switch is connected to an operating lever mechanism (FIG. 8) comprising a billet contact roller **139** journalled to a lever arm **141** that is pivotally mounted at **143** to support girders **61** of the transfer device **41**. The lever arm **141** has a counterweight **145** that returns the lever arm to the vertical upright position from a lowered or depressed position while it engages the billet or slab crossing the transfer device. The lever arm **141** is also connected to a cable **147**, preferably wire rope, that is encapsulated by a surrounding tubular conduit or pipe **149** that protects the cable from heat and hot metal or hot scale falling from the billets, that might damage the wire rope **147**. The wire rope **147** connects the lever arm **141** to the appropriate switch mounted on the enclosures **133**, **135**, and **137**.

The foregoing describes one embodiment of the invention, but the invention may have more than one modification. FIG. 9 illustrates schematically another arrangement of a billet or slab conveyor mechanism **151** that is pivotable about a fixed sprocket **153**. In this modification of the transfer device described herein, the rollers **155** are mounted in guide rails **157** extending between a fixed sprocket **153** and a vertically movable sprocket **159**. The rollers **155** support the upper portion of an endless conveyor chain **161** that loops around the fixed sprocket **153** and the vertical movable sprocket **159**. In this modification of the invention, the fixed sprocket **153** would be the drive sprocket, and the vertically movable sprocket **159** would be the driven or following sprocket.

The guide rails **157**, the rollers **155**, and the driven sprocket **159** are mounted to a cylinder-piston arrangement **163** by means of which the sprocket **159**, the rails **157**, as well as one end of the conveyor chain **161**, are movable vertically.

Thus, when billets or slabs **89** are ready for transferance to the skid rails **119**, the fluid is admitted to the cylinder-piston arrangement **163**, and the rails, the rollers, and the movable sprocket, move upwardly together, while at the same time the conveyor chain **161** moves in the direction of the arrow N. The chain **161** then lifts the billets or slabs **89** and carries them toward and deposits them on the skid rails **119**. As soon as all billets or slabs have been deposited on the skid rails, the conveyor mechanism returns to its initial horizontal position (shown in dotted outline in FIG. 9) and more billets or slabs are then allowed to move onto the transfer device in the manner described herein.

A feature of the invention is that the billet or strand transfer apparatus is simple and compact, and only minimum length run-out tables are required with multi-strand continuous casting machines.

Other features of the invention are: that the transfer of billets or slabs to skid rails and the stacking thereon is automatically performed; that more than a single billet or slab is transferred at the time; and that the transfer and stacking are coordinated with production of billets or slabs by the multi-strand continuous casting machine.

A feature of the invention is that the transfer apparatus is readily and easily adapted to automatically handle billets or slabs of different lengths. Billets or slabs that are as short as 5 feet and as long as 30 feet may be handled by the apparatus with equal facility and dispatch.

Although the invention has been described herein with a certain degree of particularity, it is understood that the disclosure has been made only as an example and that the scope of the invention is defined by what is hereinafter claimed.

What is claimed is:

1. A continuous casting machine of the multistrand type comprising:

(a) casting molds wherein molten metal partially solidifies and forms cast strands;

(b) pinch rolls for continuously withdrawing a strand from each of said molds;

(c) cooling means located between said pinch rolls and

said mold to cool the outer surfaces of each of said strands and accelerate solidification of said strand;
(d) means to change the direction of movement of each of said strands from a vertical direction to a horizontal direction;
(e) means to straighten each of said strands and discharge the same in a substantially horizontal direction;
(j) means to sever each of said strands into incremental units of selected lengths;
(g) a frame located adjacent the discharge end of said continuous casting machine;
(h) a plurality of spaced apart powered rollers mounted to said frame supporting a plurality of said severed incremental units, said units moving in a first direction generally in the direction of the horizontal movement of said units away from said machine;
(i) a plurality of spaced apart guide means mounted to said frame defining paths along which said incremental units move in said first direction;
(j) a plurality of first means disposed at preselected locations, to arrest the movement of an incremental unit along each of said paths;
(k) second unit arresting means movable into each of said paths to prevent more than one said incremental unit from occupying a portion of a respective path occupied by a first unit;
(l) third means located in the spaces between adjacent powered rollers that is movable to engage and lift said incremental units off of said powered rollers, each of said third means including:
(i) a pair of spaced apart sprockets, at least one of which is power driven; and
(ii) an endles chain surrounding said sprockets and having top and bottom runs; and
(iii) guide bars mounted to said frame and lying alongside of the top run of said endless chain; and
(iv) spaced apart rollers mounted in said guide bars supporting said top run of said chain; and
(v) blocks mounted to a plurality of links of said chain, each block having dimensions differing from an adjacent block so that all of said blocks collectively form an elongate tapering articulated wedge extending parallel to the axes of the incremental unit supporting powered rollers, the smaller end of said wedge being the leading end when said wedge moves in a second direction generally perpendicular to said first direction;
(vi) a pusher block pivotally mounted to said endless chain at the larger end of said wedge configuration, said pusher block having means engaging said guide bars to maintain said pusher block in contact with at least one incremental unit on said blocks and to move said unit in said second direction;
(m) fourth means for actuating said third means so that said third means transfers said raised incremental units in said second direction; and
(n) fifth means for removing said units from said third means.

2. Apparatus for receiving and transferring incremental units severed from a plurality of horizontal continuous strands of metal discharging from a multistrand continuous casting machine comprising:
(a) a frame located adjacent the discharge end of said continuous casting machine;
(b) a plurality of spaced apart powered rollers mounted to said frame supporting a plurality of said incremental units for moving said units in a first direction generally in the direction of the horizontal movement of said units away from said machines;
(c) a plurality of spaced apart guide means mounted to said frame defining spaced apart paths along which said incremental units move in said first direction;
(d) first stop means for engaging the leading end of a first incremental unit traveling along a path to arrest the movement of said first unit along said path;
(e) second unit stopping means positioned in spaced apart relation to said first stopping means along said path adapted for movement into and out of said path;
(f) switch means actuated by said moving first incremental unit to move said second stop means into the path behind said first unit thereby preventing entry of a second unit into the portion of said path occupied by said first unit;
(g) third unit stopping means positioned along said path in spaced relation to said second stopping means adapted for movement into and out of said path;
(h) switch means actuated by a second unit traveling along said path to move said third unit stopping means into said path behind said second unit thereby preventing entry of a third unit into the portion of said path occupied by said second incremental unit;
(j) means for driving one of said wheels;
adjacent incremental unit supporting powered rollers;
(j) means for rdiving one of said wheels;
(k) an endless band surrounding said wheels and forming a top run and a bottom run;
(l) a guide bar lying alongside of the top run of said endless band;
(m) spaced apart rollors mounted in said guide bar supporting the top run of said endless band;
(n) a plurality of adjacent blocks individually mounted to said band, each said block having a height measured perpendicularly to the band surface that is different from the height of adjacent blocks, with all of the blocks collectively forming an elongated articulated wedge configuration, the smaller end of said wedge being the leading end when said wedge moves in a second direction generally perpendicular to said first direction;
(o) a pusher block pivotally mounted to the band at the larger end of said wedge configuration;
(p) means on said pusher block engaging said guide bar to maintain said pusher block in an operative position for engagement with said incremental units as long as said means engages said guide bar, said pusher block pivoting downwardly to an inoperative position when said means disengages from said guide bar;
(q) means acting responsively to the positioning of said third unit stopping means in said paths for activating the means driving said one wheel and said endless bands whereby said elongate articulated wedge configuration moves in said second direction, said wedge configuration engaging said incremental units and raising them off of said powered rollers and moving said units in said second direction.

3. The invention of claim **2** wherein:
(a) the means acting responsively to the positioning of said third unit stopping means is a timing device.

4. Apparatus for receiving and transferring incremental units severed from a plurality of horizontal continuous strands of metal discharging from a multistrand continuous casting machine, comprising:
(a) a frame structure located adjacent the discharge end of said continuous casting machine;
(b) a plurality of spaced apart powered rollers mounted to said frame structure supporting a plurality of said incremental units for moving said units in a first direction generally in the direction

of the horizontal discharge of said units from said machines;

(c) a plurality of spaced apart guide means mounted to said frame structure defining spaced apart paths along which said incremental units move in said first direction;

(d) first stop means for engaging a first incremental unit traveling along a path to arrest the movement of said first unit along said path;

(e) individual second unit stopping means each positionable in a respective path for preventing the movement of a second incremental unit into a portion of said path occupied by a first unit;

(f) individual third unit stopping each positionable in a respective path for preventing the movement of a third incremental unit into a portion of said path occupied by a second unit;

(g) a pair of spaced apart wheels mounted between adjacent incremental unit supporting powered rollers;

(h) means for driving one of said wheels;

(i) an endless band surrounding said wheels and having a top run and a bottom run;

(j) a guide bar lying alongside of the top run of said endless band;

(k) spaced apart rollers mounted in said guide bar supporting the top run of said endless band;

(l) a plurality of adjacent blocks individually mounted to said band, each said block having a different height measured perpendicularly to the band surface than the adjacent blocks, with all of the blocks collectively forming an elongate articulated wedge configuration, the smaller end of said wedge being the leading end when said wedge moves in a second direction generally perpendicular to said first direction;

(m) a pusher block pivotally mounted to the chain at the larger end of said wedge configuration;

(n) means on said pusher block engaging said guide bar to maintain said pusher block in an operative position for engagement with said incremental units as long as said means engages said guide bar, said pusher block pivoting downwardly to an inoperative position when said means disengages from said guide bar;

(o) first switch means operable by said incremental unit to activate a first one of said second unit stopping means and thereby prevent a second incremental unit from moving onto the portion of the path occupied by said first unit, all of said other second unit stopping means acting in unison along with said first one of said second unit stopping means;

(p) second switch means operable by a second incremental unit entering an available portion of one of said paths not occupied by a first incremental unit or closed by said second unit stopping means to activate a first one of said third unit stopping means and thereby prevent a third incremental unit from moving onto the portion of said path occupied by said second incremental unit, all of said other third unit stopping means acting in unison along with said first one of said third unit stopping means;

(q) a timer apparatus connected in circuit with said switches whereby after the last unit stopping means moves into operative position, said timer mechanism starts to measure a preselected time interval; and

(r) switch means connected in circuitry to said timer mechanism and said conveyor chains which closes when said preselected time interval passes and through which electrical current passes to the motors driving said conveyor chains whereby said incremental units are raised off of said rollers and transferred in said second direction.

5. Apparatus for receiving and transferring incremental units severed from continuous cast strands discharging in a horizontal direction from a multistrand continuous casting machine, comprising:

(a) a frame;

(b) a plurality of spaced apart rollers mounted to said frame and supporting said incremental units moving thereonto in the first direction of horizontal movement of said strands;

(c) means located in the spaces between adjacent unit supporting rollers for lifting said incremental units off of said rollers and moving said raised units in a second direction; and

(d) means for periodically actuating said unit lifting means when at least one unit is supported on said rollers, whereby said unit is transported by said unit lifting means in said second direction.

6. The structure of claim **5** including:

(a) guide means associated with said rollers defining at least one path along which said incremental units move;

(b) stop means movable into said path to prevent entry of a second unit onto the portion of said path occupied by a first unit; and

(c) means to actuate said stop means in a sequence before said unit lifting means operates when a first incremental unit occupies a first portion of said path preventing the entry of second unit onto the portion of said path occupied by said first unit.

7. Apparatus for receiving and transferring incremental units severed from a plurality of horizontal continuous strands of metal discharging from a multistrand continuous casting machine, comprising:

(a) a frame;

(b) a plurality of spaced apart powered rollers mounted to said frame supporting a plurality of said incremental units and moving said units in a first direction generally in the direction of the horizontal movement of said units from said machine;

(c) a plurality of spaced apart guide means mounted to said frame defining spaced apart paths along which said incremental units move in said first direction;

(d) first means disposed at a location along each said path to arrest an incremental unit moving along said path;

(e) second unit arresting means movable into each of said paths to prevent a second incremental unit from occupying the portion of a respective path occupied by a first unit during any one period of time;

(f) third means located in the space between adjacent unit supporting rollers and movable so as to lift said incremental units off of said rollers;

(g) fourth means for actuating said third means whereby said third means moves and transfers the raised incremental units supported thereon in a second direction; and

(h) fifth means for removing said units from said third means.

8. The invention of claim **7** including:

(a) first switch means associated with each path and actuated by an incremental unit moving along said path;

(b) means acting responsively to said first switch means to move said first unit arresting means into said path;

(c) second switch means associated with each path and actuated by said incremental unit moving along said path;

(d) means acting responsively to said second switch means to move said second unit arresting means into said path behind said first unit; and

(e) means actuated by said third means to move said first and second unit arresting means out of said path when said incremental unit has been removed from

said third means whereby additional incremental units move onto said apparatus.

9. The invention of claim 8 wherein:

(a) said third means includes

(i) a pair of spaced apart wheels, one of which is a power driven wheel, and

(ii) a continuous band surrounding said wheels, and

(iii) a plurality of blocks individually mounted to the outer surface of said band, all of said blocks collectively forming an elongate wedge with its smaller end being the leading end when said third means moves in said second direction.

10. The invention of claim 8 wherein:

(a) said third means includes:

(i) a pair of spaced apart sprockets, at least one of which is power driven, and

(ii) an endless chain surrounding said sprockets and having top and bottom runs, and

(iii) guide bars mounted to said frame structure and lying along both sides of the top run of said endless chain, and

(iv) spaced apart rollers mounted in said guide bars supporting said top run of said chain, and

(v) a block mounted to each one of a plurality of links of said chain, each block having dimensions differing from an adjacent block so that said blocks collectively form an elongate tapering articulated wedge extending parallel to the direction of the axes of said rollers with the smaller end of said wedge being the leading end when said third means moves in said second direction, and

(vi) a pusher block pivotally mounted to said chain at the larger end of said wedge configuration, said pusher block having means engaging said guide bars to maintain said pusher block in contact with the incremental units supported on said blocks and to move them in said second direction.

11. The invention of claim 8 wherein:

(a) said third means includes:

(i) a pair of spaced apart wheels, one of which is a powered drive wheel and the other of which is a driven wheel;

(ii) an endless band surrounding said wheel; and

(iii) means for pivoting said driven wheel and said band about said drive wheel whereby said endless band engages and lifts said incremental units off of said rollers; and

(b) said second direction is toward said raised driven wheel.

References Cited

UNITED STATES PATENTS

2,829,758	4/1958	Temple	198—32
3,138,238	6/1964	DeGood et al.	198—127
3,281,903	11/1966	Ross	164—263 X

FOREIGN PATENTS

1,465,358	12/1966	France.
744,359	2/1956	Great Britain.

J. SPENCER OVERHOLSER, Primary Examiner

R. S. ANNEAR, Assistant Examiner

U.S. Cl. X.R.

164—282; 198—30, 34

FO-1310
(5/67)

UNITED STATES PATENT OFFICE

67:1

CERTIFICATE OF CORRECTION

Patent No. 3,464,481 Dated September 2, 1969

Inventor(s) Harry F. Hartzell, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 4, line 14

---means--- has been omitted following "stopping"

Claim 2, following line 25, add

---i) a pair of spaced apart wheels mounted between adjacent incremental unit supporting powered rollers;---

Claim 2, delete lines 27, 28, 29

SIGNED AND
SEALED
APR 28 1970

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents