Jan. 27, 1942. W. C. WEIDNER ET AL 2,271,213

METHOD AND APPARATUS FOR MANIPULATING SLABS AND THE LIKE

Filed Nov. 13, 1937 3 Sheets-Sheet 1

FIG. 1

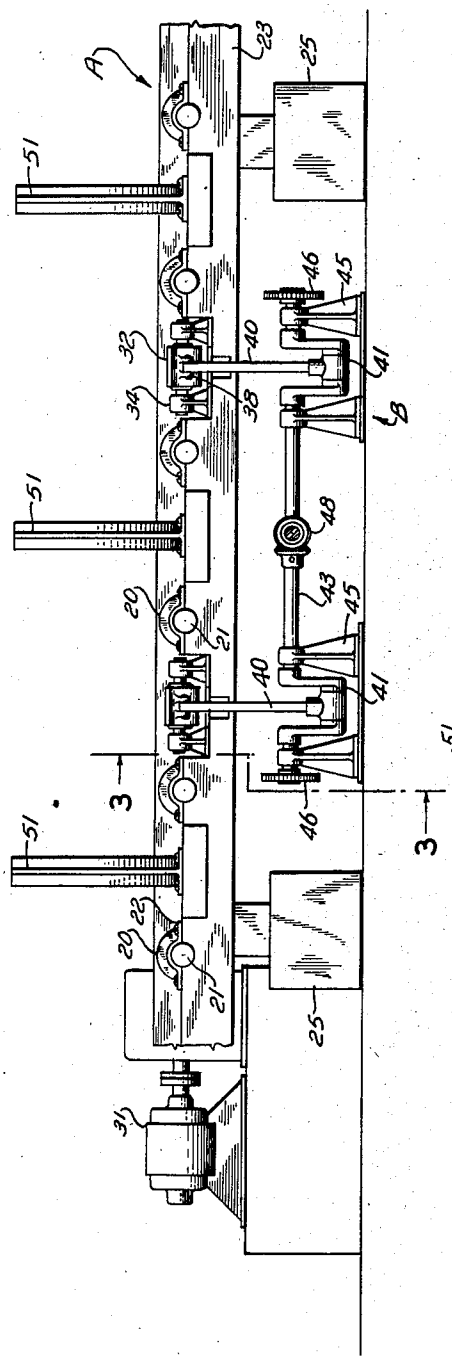
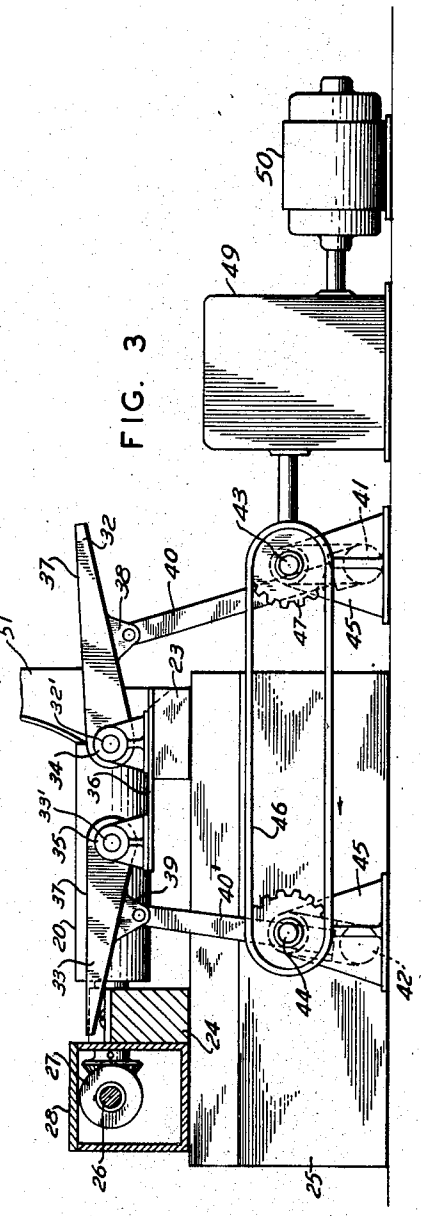


FIG. 3



INVENTORS
WILLIAM C. WEIDNER
ARTHUR M. KELLER
BY E. E. Greenewald
ATTORNEY

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METHOD AND APPARATUS FOR MANIPULATING SLABS AND THE LIKE

Filed Nov. 13, 1937 3 Sheets-Sheet 2

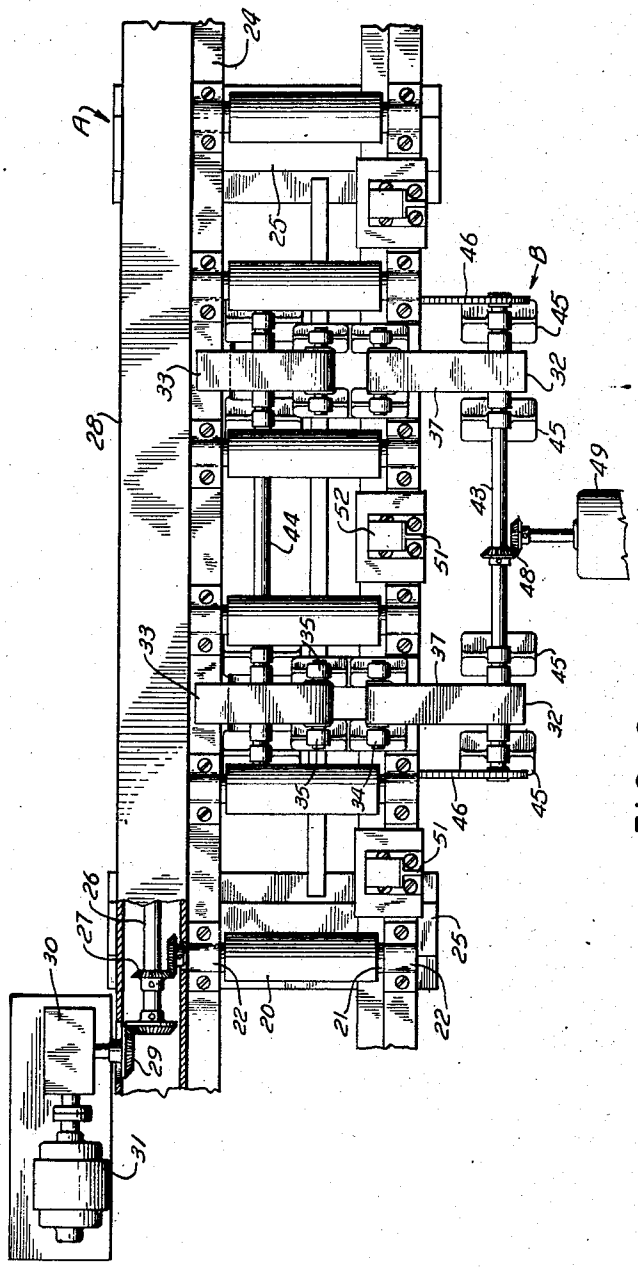

FIG. 2

INVENTORS
WILLIAM C. WEIDNER
ARTHUR M. KELLER
BY F. E. Greenewald
ATTORNEY

Jan. 27, 1942. W. C. WEIDNER ET AL 2,271,213

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Filed Nov. 13, 1937 3 Sheets-Sheet 3

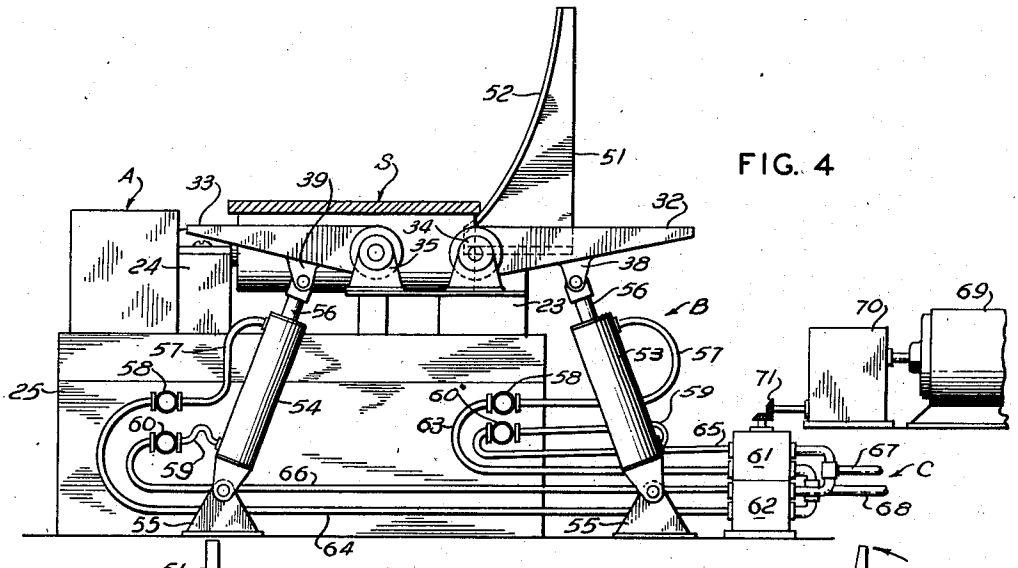

FIG. 4

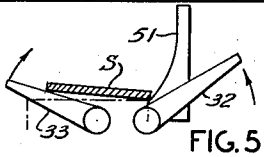

FIG. 5

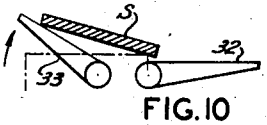

FIG. 10

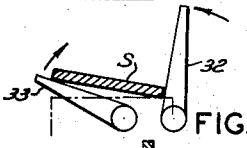

FIG. 15

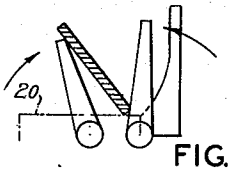

FIG. 6

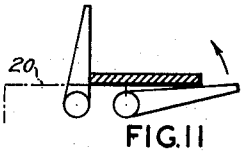

FIG. 11

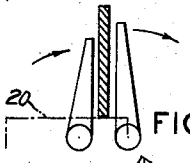

FIG. 16

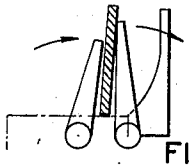

FIG. 7

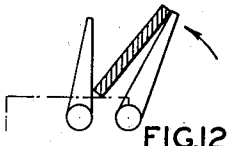

FIG. 12

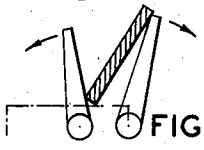

FIG. 17

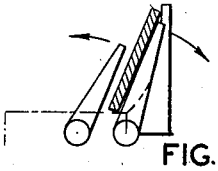

FIG. 8

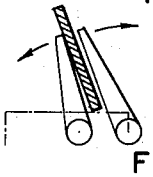

FIG. 13

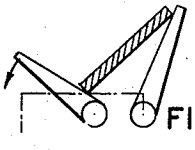

FIG. 18

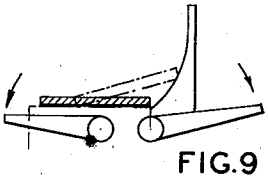

FIG. 9

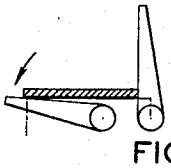

FIG. 14

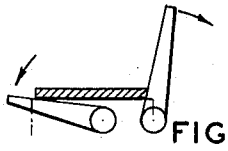

FIG. 19

INVENTORS
WILLIAM C. WEIDNER
ARTHUR M. KELLER
BY E. E. Greenewald
ATTORNEY

Patented Jan. 27, 1942 2,271,213

UNITED STATES PATENT OFFICE

2,271,213

METHOD AND APPARATUS FOR MANIPULATING SLABS AND THE LIKE

William C. Weidner, Wood-Ridge, and Arthur M. Keller, Springfield, N. J., assignors to The Linde Air Products Company, a corporation of Ohio

Application November 13, 1937, Serial No. 174,286

20 Claims. (Cl. 29—81)

The present invention relates to manipulators for rolling mills or the like, and more particularly to a method and apparatus for turning over a steel slab or article having a width substantially greater than its thickness after a surface treatment on one of its sides and so that the opposite untreated surface may be given a surface treatment when in the horizontal position.

A principal object of the present invention is to provide a method and mechanism for overturning hot steel slabs in such a manner as to avoid distortion of the slab or injury to the mechanism.

Other objects of the invention are to provide mechanism for turning slabs carried by the roll table of a steel rolling mill through an angle of 180° about a longitudinal axis in such a manner that the slab is returned to approximately the same portion of the table and with an edge accurately aligned in a desired position with respect to the ends of the rollers; to provide such a slab turning mechanism that may be added to a section of an existing roller conveyor table with relatively little alteration of the table; and to provide a device for overturning steel slabs or articles which have been surface conditioned or desurfaced on a horizontal surface and which are to be surface conditioned on the opposite surface after the slab has been overturned.

The above and other objects and the novel features of the invention will become apparent from the following description in connection with the accompanying drawings, in which:

Fig. 1 is an elevational view partly in section of a slab manipulator embodying the present invention applied to a section of a steel mill conveyor table;

Fig. 2 is a plan view of the manipulator and conveyor table shown in Fig. 1;

Fig. 3 is a view of a cross section taken on the line 3—3 of Fig. 1, showing an exemplary driving mechanism for the manipulator;

Fig. 4 is a similar view showing another form of arm elevating and controlling mechanism according to the invention;

Figs. 5 to 9, inclusive, are simplified diagrammatic views showing various relative positions of the arms of the slab manipulator shown in Figs. 1, 2, and 3 when turning over a slab;

Figs. 10 to 14, inclusive, are diagrammatic views showing various positions of the arms of the form of manipulator illustrated in Fig. 4 when turning a slab by means of the movable arms alone; and

Figs. 15 to 19, inclusive are similar views of another method of turning the slab by means of the movable arms only.

Previously-employed slab manipulators have overturned slabs by lifting the slabs from one conveyor between sets of arms, turning the slabs about one edge as an axis and laying the slabs down on an adjoining conveyor. This method of turning slabs requires the provision of two parallel conveyors or of a conveyor table of great width. It has also been proposed to move the slab, after it has been overturned in the above-described manner, back to the same conveyor table by providing additional lateral conveying means.

By the present invention, there is provided a manipulator mechanism for turning slabs which does not require additional conveyor means, which may be readily added to an existing conveyor in a steel mill of normal width sufficient to carry the slabs being conveyed, which does not lift the slab entirely from the conveyor, and which returns the slab to the conveyor in desired alignment with the ends of the conveyor rollers irrespective of the original position of the slab on the rollers before turning. These and other results are attained by providing two or more slab raising and tilting arms, each between two rollers of the conveyor, which arms normally, in the at-rest position, are entirely below the level of the slab supporting portions of the rollers so that the slab may be moved longitudinally along the conveyor into and out of position over the arms. The arms are pivoted at one end and power mechanism is applied to raise them about their pivots through an arc greater than 90°.

The major portion of the weight of the slab is always carried by the conveyor rollers and thus the arms are not required to lift the full weight of the slab. Since the edge of the slab is supported upon the rollers during the overturning procedure, the lateral sliding of the slab along the rollers may be facilitated by causing them to simultaneously rotate with the further advantage that the wear is uniformly distributed and the movement is smooth and regular.

By the manipulator mechanism of the present invention, several methods of inverting the slab may be practiced. By one method, the slab is rotated about one of its edges which remains in contact with the rollers and is turned until it ently contacts with a set of stationary abutments or slide brackets which guide the moving edge of the slab as the slab is returned inverted to the conveyor rollers. By another method, ac-

cording to the invention, the use of stationary abutments is omitted and the slab is caused to slide laterally over one set of arms by raising the other set of arms which remain upright while the slab is tilted to a vertical position between the arms. The two sets of arms then move together until the slab is supported entirely on the set of arms which were first raised, which arms then lower the slab to the conveyor rollers inverted as desired. By still another method, the slab is first raised on edge with all arms upright. Both sets of arms then move to cause the slab to lay over on the set of arms whose pivots are nearest the ends of the rollers, which arms then remain upright at an angular position while the other set of arms is lowered so that the lower edge of the slab slides laterally along the conveyor rollers and the upper edge is guided along the upright arms until the slab is returned to the conveyor rollers. Either of these methods of turning the slab may be used according to the conditions existing in the steel mill where the manipulator is to be used. Such conditions will vary because the manipulator of the present invention may preferably be added to a section of an existing conveyor.

Referring now to the drawings, and particularly to Figs. 1, 2, and 3 which illustrate a preferred type of manipulator embodying this invention, a portion of a steel mill roller conveyor of the customary type is shown generally at A; and combined therewith is a mechanism, shown generally at B, for manipulating slabs or the like that are carried by the conveyor A. The conveyor comprises a set of cylindrical rollers 20 which are supported horizontally and parallel to each other and spaced apart at substantial distances from each other. The rollers 20 are termed "live rollers," for they are mechanically driven. Axles 21 project from each end of each roller and are journalled in bearings 22 supported by longitudinal frame members 23 and 24. The frame members are carried by supports 25 located at intervals under the conveyor. The ends of axles 21 which project through the bearings 22 on the frame member 24 are geared to a longitudinal drive shaft 26 by means of mitre gears 27. The shaft 26 is journalled in bearings disposed within a boxlike covering 28 which is secured lengthwise along the frame member 24 and which protects the shaft 26 and the gearing. The shaft 26 is connected by mitre gears 29 to the power output shaft of a speed reducer 30, to the input shaft of which is connected an electric motor 31.

The manipulator B comprises a set of arms 32 which are pivoted along an axis 32' close to the ends of the rollers nearest the frame member 23 and a second set of arms 33 which are pivoted along an axis 33' between the frame members 23 and 24. The axes 32', 33' lie in a plane parallel to but below a plane tangent to the cylindrical work-supporting surfaces of the rollers. The arms 32 and 33 are arranged in pairs, each pair being between two rollers of the conveyor as seen in Figs. 2 and 3 where the arms are in the so-called rest position, being substantially horizontal with their swingable ends furthest apart. A plurality of such pairs is provided, there being sufficient pairs of arms to manipulate the slab when it is at rolling temperatures without distorting it. However, in the drawings, only two such pairs are shown in the interest of clearness. The pivoted end of each arm 32 has two trunnions extending to each side thereof which are respectively journalled in a pair of pillow blocks 34. The arms 33 likewise have similar trunnions journalled in pillow blocks 35. The pillow blocks 34 and 35 are of such height that when the arms 32 and 33 are in the horizontal or rest position, no part thereof will extend above the carrying level area of the conveyor rollers. The pillow blocks 34 and 35 are supported upon a plate or bracket 36 which is carried by the longitudinal member 23. The arms 32 and 33 have upper surfaces 37 adapted to contact the slab and the lower surfaces of the arms 32 and 33 are provided intermediate of their ends with clevises 38 and 39, to which are pivotally connected the upper ends of connecting rods 40 and 40'. The lower ends of rods 40, 40' are connected to the crank portions 41, 42 of horizontal drive shafts 43 and 44 which are journalled in suitable bearings 45. The drive shaft 43 is parallel to, and located at a relatively small distance to one side and below the frame member 23. The other drive shaft 44 is located under the conveyor and substantially directly below the clevises 39 when the arms 33 are horizontal. The shafts 43 and 44 are parallel and geared together, so as to turn simultaneously, by means of chains 46 which engage the sprockets 47 of equal diameter mounted on each end of the drive shafts 43 and 44. The shaft 43 may be turned by means of a set of mitre gears 48 which connect it to the power output shaft of a speed reducer 49, the power input shaft of which is preferably driven independently by an electric motor 50.

To receive the raised edge of the slab and guide the same when the slab slides back onto the conveyor, there is provided in this embodiment of the invention, a set of vertical abutments or guide brackets 51 which are mounted on the horizontal frame member 23 at points intermediate between the pairs of movable arms. Each abutment 51 is preferably provided with a suitably curved guiding face on the side adjacent the center line of the conveyor and so mounted as to be laterally adjustable for setting in positions for accurately aligning the edge of the slab after it has been overturned. The radius or throw of the cranks 41 and 42 and the distances between the axes of the trunnion bearings 34 and 35 and the respective clevises 38 and 39 are so arranged that the arms will be moved through the desired angle when the cranks make a complete turn. The arms 33 in particular should move through an angle greater than 90°, for example, about 15° beyond the vertical position. The shafts 43 and 44 are geared together by the chains 46 so as to maintain a fixed relationship between the successive positions of the cranks 41 and 42. The position of the cranks shown in Fig. 3 may be termed the "rest" position, since this position is resumed after a slab turning operation is completed and maintained when the manipulator is not in operation. One turn of the cranks completes the cycle of turning over the slab. The relation between the cranks shown in the figure is the correct relation when the distances between the shafts 43 and 44 and trunnions 32' and 33' and the radii of rotation of the cranks 41 and 42 and of the clevises 38 and 39 are proportioned substantially as shown in the figure.

A preferred procedure of turning over a slab is illustrated diagrammatically by Figs. 5 to 9, inclusive. When a slab is moved along the conveyor into a position over the set of arms 33, the conveyor motor 31 is stopped and the slab manipulator motor 50 is started. The shafts 43 and

44 thereupon rotate clockwise at the same rate, so that both sets of arms 32 and 33 are caused to rise. The set of arms 33 engages with the slab, as shown in Fig. 5, where the slab is indicated in cross section at S. The arms 33 engage the left edge of the slab S and raise it so that the slab stands on its right-hand edge upon the conveyor rollers. The right-hand edge of the slab is engaged by the arms 32 as they rise so as to move the right-hand edge toward the left, as seen in Fig. 6. The arms 32 having started upward slightly sooner than the arms 33 will have reached their extreme position, while the arms 33 are still moving to the right. Both sets of arms then move in unison to the right as shown in Fig. 7, until the extreme limit of movement of the arms 33 is reached. The arms 33 thereupon begin to return as shown in Fig. 8, while the arms 32 continue their downward movement and lower the upper edge of the slab into gentle contact with the guide faces 52 of the abutments 51. The arms 32 now move entirely out of contact with the slab. The lower edge of the slab, which was the right-hand edge, now slides leftward along the rollers 20 and maintains contact with the descending arms 33. This lateral sliding may be facilitated by causing the rollers 20 to rotate slowly at this time. The upper edge of the slab, which was formerly the left-hand edge, slides down on the guide face 52 of the abutments 51, as shown in Fig. 9. The relatively slow movement of the arm 33 prevents the slab from coming down on the conveyor roller violently, and when the slab reaches full face contact with the rollers, it will be accurately aligned therealong by the guiding faces 52 of the abutments which may me adjusted according to the position desired. When the arms 32 and 33 have returned to their rest position, the motor 50 is preferably automatically stopped and the conveyor motor 31 may then be operated to move the slab along the conveyor in the desired direction for further treatment.

Another form of arm lifting and controlling mechanism embodying this invention is shown in Fig. 4. Here, however, instead of by means of connecting rods and cranks, the arms are raised by means of fluid pressure cylinders 53 and 54. These power cylinders may be pivoted at their lower ends to supports 55 and have the ends of their piston rods 56 pivotally connected to the clevises 38 and 39. A power cylinder is preferably provided for each of the arms. Flexible conduits 57 connect the upper ends of the cylinders 53 and 54 with right and left-hand manifolds 58, while the lower ends of the cylinders are connected by means of flexible conduits 59 with longitudinal manifolds 60. Each of the manifolds is connected to a fluid controlling valve having a timing arrangement, shown generally at C. Two sets of fluid flow timing valves are provided, one at 61 and one at 62, the right-hand and left-hand conduits 58 being connected respectively to the lower outlets of the valves 61 and 62 by conduits 63 and 64 and the manifolds 60 being connected with the upper outlets of the valves 61 and 62 by conduits 65 and 66 respectively. Fluid under pressure is supplied to the valves 61 and 62 by the branched conduit 67 and the branched conduit 68 conducts used fluid from the valves.

The fluid provided may be liquid or gaseous and of any composition commonly used for operating power cylinders. The fluid distributing rotors which operate within the valves 61 and 62 have passages therein so arranged that fluid is admitted and discharged from either end of the cylinders 53 and 54 in the desired manner as the rotors of the valves 61 and 62 are turned through a complete revolution so that the arms will go through the desired sequence of movements. The rotors of the valves 61 and 62 may be connected together and turned simultaneously by means of a power source, such as a small electric motor 69 which is connected to the projecting stem of the valve rotors by means of a speed reducer 70 and mitre gearing 71. Other fluid pressure impulse timing arrangements may be provided, such as, for example, a set of individual electrically operated valves to which electric impulses are applied by means of a suitable electrical timing device.

With this arrangement of apparatus, the sets of arms 32 and 33 may be made to go through the same cycle of movements, as previously described in connection with the mechanism shown in Figs. 1, 2, and 3, by a suitable arrangement of the valve passages of the rotors in the valves 61 and 62. In this event, the slide abutments 51 are to be used as previously described. However, the rotors of valves 61 and 62 may have the passages therein so arranged that other slab turning procedures may be effected which do not require the presence of the abutments 51.

One such method is illustrated by Figs. 10 to 14. With the abutments 51 omitted, the arms 33 are caused to rise to the vertical position, while the arms 32 remain in the rest position. This movement causes the slab S to slide to the right as shown in Fig. 10, so that it is mainly over the arms 32. As seen in Fig. 11, the arms 33 remain stationary in the vertical position, while the arms 32 turn the slab up on its edge. When both sets of arms reach the vertical position, they move simultaneously to the left until the slab rests entirely on the set of arms 33, as seen in Fig. 13. The arms 33 then continue to move downward to lower the slab down on the conveyor rollers, while the arms 32 return to and remain in the vertical position. The lowermost edge of the slab is thereby prevented from sliding to the right as the slab is being lowered and is thus properly positioned laterally when the slab is completely overturned. When the slab has returned to its proper position on the conveyor, the arms 32 are brought down to the rest position.

The rotors of the valves 61 and 62 may also be timed and arranged to provide such pressure impulses to the power cylinders 53 and 54, so that still another slab turning procedure according to the invention may be effected. Such procedure is shown in Figs. 15 to 19. As seen in Fig. 15, the arms 32 are raised and immediately thereafter the arms 33 are raised to stand the billet on edge. Fig. 16 shows the slab standing on edge between the sets of arms which are both vertical. From this position, both sets of arms move to the right a sufficient distance, to cause the slab to rest against the arms 32 at an angle which is great enough to cause the lower edge of the slab to slide to the left against arms 33, as seen in Fig. 17. In Fig. 18, the arms 33 are being lowered, while the arms 32 remain fixed in the angular position so that the upper edge of the slab slides in contact with the arms 32, while the lower edge of the slab slides along the conveyor rollers while maintaining contact with the descending arms 33, to position the slab laterally. When the slab S is completely overturned and disposed horizontally on the conveyor rollers,

the arms 32 are brought down to the rest position.

The slab manipulator of the present invention is especially suitable for overturning slabs which have had their upper surface conditioned by a surface removing operation, such as is effected by desurfacing while at an elevated rolling temperature by the progressive application of streams of oxygen on the surface. A hot slab to be surface conditioned on both sides may be conveyed longitudinally along the conveyor under a suitable high temperature surface treating device which conditions the upper surface, then moved along the conveyor into position to be overturned while still hot by the manipulator herein described, and then passed back by the conveyor while hot under the same treating device or forwardly under another similar treating device to have its opposite surface conditioned.

The manipulator of the present invention is, however, not limited to the above-described use between surface conditioning operations but is adapted for overturning slabs when they are cold as well as hot between rolling operations or in connection with the handling and processing of any other bodies of similar shape. Obviously, certain features of the invention may be used independently of others and changes may be made in various details of the apparatus without departing from the essentials of the invention.

We claim:

1. A method of overturning a steel slab or the like initially supported horizontally upon a conveyor, such method comprising rotating said slab upwardly and through an angle of 180° about one of its edges that extends lengthwise of said conveyor, while keeping such edge in contact with and supporting the slab upon said conveyor, by engaging said slab with pairs of cooperating arms upwardly rockable about laterally fixed spaced axes; effecting a limited lateral displacement of said edge while supported on said conveyor by controlled rocking movements of said arms; and, after the slab has been rotated through 90° and during the downward portion of such rotation, continuously applying resistance against said edge of said slab by said arms in contact therewith to prevent displacement of the slab laterally off the conveyor and to restore the slab to substantially its initial location on the conveyor but in an inverted horizontal position.

2. A method of overturning a steel slab or the like supported horizontally and propelled longitudinally by a multi-roller conveyor provided with arms rockable about fixed axes and movable between rolls of such conveyor, which method comprises swinging said arms about their axes through arcs of such amplitude and in such sequence that said slab is overturned by a combination of movements including rotation about one of its edges through a total angle of 180° while such edge remains in contact with and is supported by the rolls of said conveyor and transverse movement of such edge through a sufficient displacement while applying resistance to said edge during the downward portion of such rotation such that said slab is restored to a position in alignment with its former position on said conveyor but in an inverted position.

3. Method of overturning a slab or the like on a roller conveyor which comprises rotating said slab about one longitudinal edge as an axis while said edge is in contact with said conveyor; stopping said rotation when the slab has turned through an angle greater than 90°; and causing the said edge to slide transversely of the conveyor while simultaneously so guiding the opposite edge of the slab downwardly that the slab slides back to substantially its initial location on the conveyor but in an inverted position.

4. Method of overturning a slab or the like disposed horizontally on a multi-roller conveyor which comprises rotating said slab upwardly about one longitudinal edge as an axis while said edge is in contact with the conveyor rollers; stopping said rotation when the slab has turned through an angle greater than 90°; and then allowing the weight of said slab to cause said edge to slide transversely of and along the surfaces of the conveyor rollers while simultaneously so guiding the opposite edge of the slab downwardly and while so rotating the conveyor rollers that the slab slides smoothly back to substantially its initial location on the conveyor but in an inverted position.

5. Method of overturning a slab or the like on a roller conveyor which comprises sliding said slab transversely of the conveyor horizontally a substantial distance and so that one edge only remains in contact with said conveyor; and then rotating said slab about said edge as an axis through an angle of 180° while said edge is in contact with said conveyor whereby said slab is returned to substantially its initial location on said conveyor but in an inverted position.

6. A method for conditioning the surfaces of a steel slab which comprises supporting the slab horizontally on a roller conveyor so as to move said slab longitudinally; subjecting one of the horizontal surfaces of said slab to a high-temperature surface conditioning treatment while moving said slab longitudinally; stopping said movement at a desired point along said conveyor for engagement by sets of arms rockable about fixed axes and movable between rollers of said conveyor; swinging said arms about their axes to engage said slab between said sets of arms; and moving said arms through arcs of such amplitude and such sequence that said slab is overturned by a combination of movements including rotation about one of its edges through a total angle of 180° while such edge remains in contact with and is supported by the rollers of said conveyor, and transverse movement of such edge through a sufficient displacement while applying resistance to said edge during the downward portion of such rotation such that said slab is restored to a position in alignment with its former position on said conveyor but with the untreated surface horizontally positioned for conditioning; and again moving said slab longitudinally while subjecting the untreated surface to a high-temperature surface conditioning treatment.

7. A method for conditioning the surfaces of a steel slab which comprises supporting the slab horizontally upon a conveyor so as to move longitudinally; subjecting one of the horizontal surfaces of said slab to a high temperature surface conditioning treatment while moving said slab longitudinally; stopping said movement at a desired point; rotating said slab about a longitudinal edge through an angle greater than 90°; sliding said edge laterally while guiding the remaining edge so as to cause said slab to return to a position in alignment with its position before the said rotation and with the untreated surface horizontally positioned for conditioning; and again moving said slab longitudinally while sub-

jecting the untreated surface to a high temperature surface conditioning treatment.

8. The combination of a conveyor table having power-driven rollers for supporting and longitudinally propelling a steel slab or the like, and mechanism for overturning such slab by a combination of rotary and translatory movements comprising means including cooperating pairs of arms pivoted on fixed pivots below said conveyor and adapted to engage the lower surface of such slab for effecting the rotation of said slab about an eccentric longitudinal axis through a total angle of 180° while at least a substantial portion of the weight of said slab is supported by the rollers of said conveyor, and means for displacing said axis of rotation transversely of the conveyor while said slab is in contact with said rollers through a sufficient displacement such that the slab is restored to a predetermined position on said conveyor in the inverted position after the completion of said movements.

9. The combination of a conveyor table having power-driven rollers for longitudinally moving a hot steel slab or the like, and mechanism for manipulating such slab comprising means for uniformly rotating said slab about one of its longitudinal edges as an axis through an angle greater than 90° while said edge is supported upon said rollers; and stationary guide means for engaging the opposite longitudinal edge of said slab after such rotation and for guiding said edge so as to cause said slab to slide back into contact with substantially the same portions of the conveyor table but in an inverted position.

10. The combination of a conveyor table having power-driven rollers for longitudinally moving a hot steel slab or the like, and mechanism for manipulating such slab comprising sets of cooperating arms rockable about axes fixed relatively to said conveyor; and means for moving said arms about said axes in a sequence arranged for sliding said slab horizontally along said rollers and a substantial distance transversely of said table, for rotating the slab about the longitudinal edge thereof nearest the center line of the conveyor through an angle of 180° while said edge remains in contact with and is supported by said conveyor, and for preventing said slab from sliding laterally while it is being lowered into the inverted position on the conveyor whereby the slab is returned to substantially the same portion of the conveyor and in accurate alignment thereon.

11. The combination of a conveyor table having power-driven rollers and mechanism for overturning a slab or the like comprising a plurality of pivoted arms for raising the slab on one of its longitudinal edges through an arc of more than 90°, said arms being each disposed between rollers of the conveyor and adapted to assume a position below the level of the uppermost portions of said rollers when returned to the rest position; and means for receiving said slab after it has been raised by said arms and for causing the said edge to slide transversely of said conveyor along rollers so as to remain in contact with said arms while they are moved toward the rest position whereby the face of the slab that was previously uppermost is supported upon and engages the conveyor.

12. Combination as claimed in claim 11 in which said means includes a plurality of abutments projecting upward from one edge portion of said conveyor, each abutment having a guideway for contacting an edge of said slab and adapted to cause said slab to slide laterally and remain in contact with said arms while they are being lowered.

13. Combination as claimed in claim 11 in which said means includes a plurality of abutments secured to one edge portion of said conveyor, each abutment having a guideway for supporting and guiding an edge of said slab and adapted to cause said slab to remain in contact with said arms while they are being lowered toward the rest position; and means for lowering said slab from the raised position into contact with said guideways.

14. Combination as claimed in claim 11 in which said means includes a plurality of abutments secured to one edge portion of said conveyor, each abutment having a guideway for supporting and guiding an edge of said slab and adapted to cause said slab to remain in contact with said arms while they are being lowered toward the rest position; and a second set of pivoted arms adapted to push the slab laterally over the raising arms when said second set of arms is raised to a vertical position and to receive the slab from said raising arms and lower it into contact with said guideways.

15. Combination as claimed in claim 11 in which said means includes a plurality of fixed abutments secured to one edge portion of said conveyor, each abutment having a guideway for supporting and guiding an edge of said slab and adapted to cause said slab to remain in contact with said arms while they are being lowered toward the rest position; and means engaging the said edge for preventing the slab from sliding laterally while it is being raised and for lowering said slab into contact with said guideways.

16. The combination of a conveyor table having spaced-apart power-driven rollers and mechanism for manipulating a slab or the like comprising a plurality of lifting arms each disposed between pairs of said rollers and having an end nearest the center line of the conveyor pivoted in fixed bearings; a second set of arms similarly disposed and similarly pivoted but extending toward the opposite side of the conveyor from that toward which the first-mentioned set of arms extends; and mechanism for moving said sets of arms including, cranks geared together to rotate at the same rate, and connecting rods between said cranks and points intermediate the ends of said arms, the arrangement being such that at least said lifting arms are moved through an angle of more than 90° when said cranks make a complete revolution.

17. The combination of a conveyor table having spaced-apart power-driven rollers and mechanism for manipulating a slab or the like comprising a plurality of lifting arms each disposed between pairs of said rollers and having an end nearest the center line of the conveyor pivoted in fixed bearings; a second set of arms similarly disposed and similarly pivoted but extending toward the opposite side of the conveyor from that toward which the first-mentioned set of arms extends; mechanism for moving said sets of arms including individual fluid-operated power cylinders connected to and arranged to raise and lower each arm; and means for so regulating and timing the flow of fluid to and from said power cylinders that said first set of arms is raised to a vertical position thereby shifting said slab laterally over the second set of arms, said second set of arms is raised to a vertical position thereby turning said slab on edge between arms, both

sets of arms are moved laterally together until said slab is tilted to an appreciable angle, said first set of arms is lowered to the horizontal position thereby returning the slab to position on the conveyor, said second set of arms is moved back to the vertical position, and finally the second set of arms is returned to the rest position.

18. The combination of a conveyor table having spaced-apart power-driven rollers and mechanism for manipulating a slab or the like comprising a plurality of lifting arms each disposed between pairs of said rollers and having an end nearest the center line of the conveyor pivoted in fixed bearings; a second set of arms similarly disposed and similarly pivoted but extending toward the opposite side of the conveyor from that toward which the first-mentioned set of arms extends; mechanism for moving said sets of arms including individual fluid-operated power cylinders connected to and arranged to raise and lower each arm; and means for so regulating and timing the flow of fluid to and from said power cylinders that said second set of arms is simultaneously raised first, the lifting arms are, next simultaneously raised to lift said slab on edge, both arms are moved laterally with the slab therebetween until the slab is at a substantial angle to the vertical, the lifting arms are then lowered while the second set of arms remains stationary, and finally the second set of arms is returned to the rest position after the slab has been returned to a predetermined position entirely on the conveyor.

19. In a slab manipulating device the combination of two sets of pivoted arms arranged in pairs, one set being adapted to raise and rotate a slab on its longitudinal edge through an angle of more than 90° and the second set being adapted to lower said slab from the vertical position, and a set of adjustable abutments having guideways adapted to receive said slab when lowered thereto by said second set of arms and to guide the upper edge of said slab into accurate alignment along the conveyor.

20. Apparatus for overturning a steel slab or the like initially supported horizontally upon a conveyor, such apparatus comprising mechanism associated with said conveyor for rotating said slab upwardly and through an angle of 180° about one of its edges that extends lengthwise of said conveyor while keeping such edge in contact with and supporting the slab upon said conveyor, said mechanism including pairs of cooperating arms rockable about axes fixed relatively to said conveyor during the entire overturning operation, said mechanism being constructed and arranged to continuously apply resistance against one edge of the slab after the slab has been rotated through 90° and during the downward portion of such rotation, to prevent displacement of the slab laterally off of said conveyor and to restore the slab to substantially its initial location on the conveyor but in an inverted horizontal position thereon.

WILLIAM C. WEIDNER.
ARTHUR M. KELLER.