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Fieser et al.

[11] **3,829,072**

[45] **Aug. 13, 1974**

[54] **METAL SLAB CONDITIONING SYSTEM**

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[52] **U.S. Cl.** .... **266/23 H,** 72/250, 148/9.5, 266/23 R, 266/23 K

[51] **Int. Cl.** **B23k 7/00,** B23k 7/06, B23k 7/10

[58] **Field of Search** .... 148/9.5, 9 R, 9.6; 214/1 Q, 1 QA, 1 QF, 1 QG; 134/5, 19, 34; 266/23 R, 23 H, 23 K, 4 S, 6 S; 212/1, 10, 11

[56] **References Cited**

UNITED STATES PATENTS

3,176,971 6/1965 Hulton et al. .... 266/23 H

3,629,015 12/1971 Yonezawa et al. .... 266/6 S X

FOREIGN PATENTS OR APPLICATIONS

876,429 9/1961 Great Britain .... 214/1 QA

OTHER PUBLICATIONS

Russian Authors' Certificate: No. 223288; A. N. Korodine; 30/10/68.

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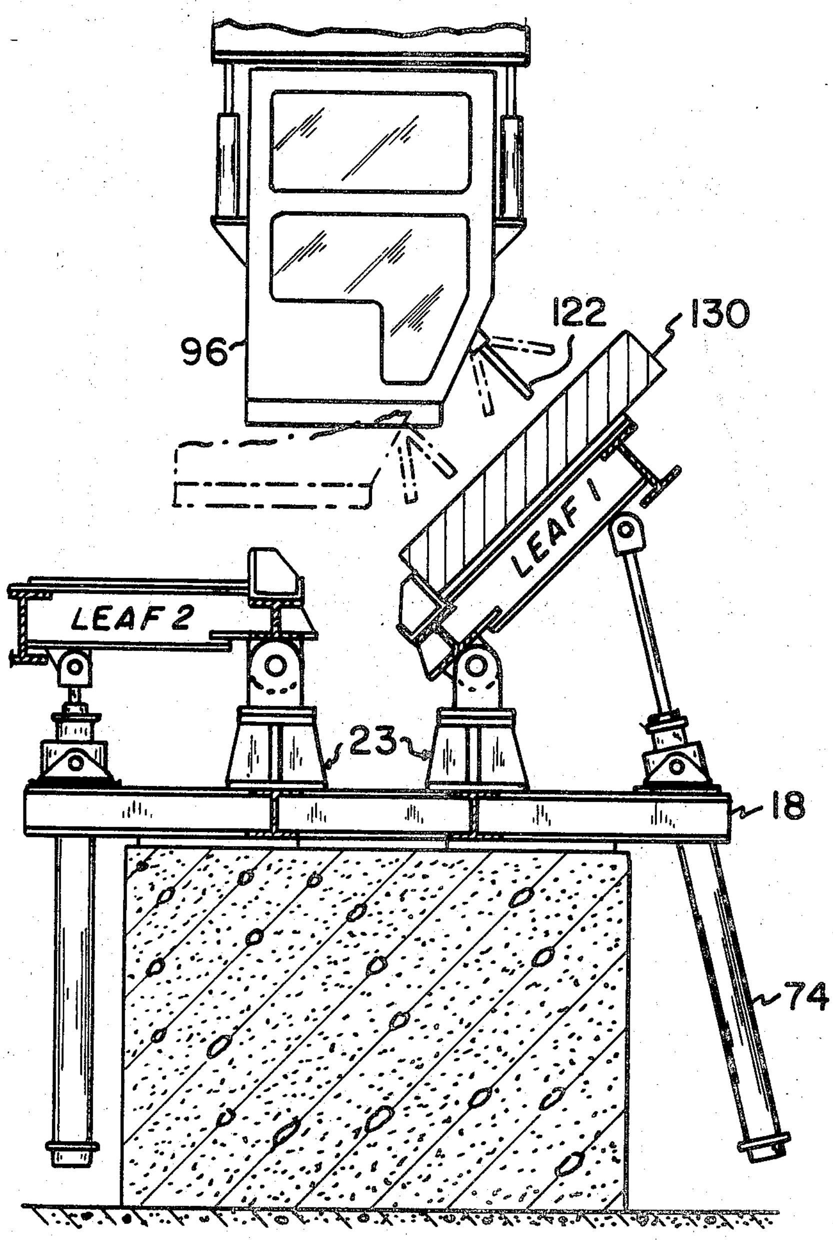
[57] **ABSTRACT**

A slab conditioning system including a pair of rotatable leaves for supporting metal slabs and a conditioning tool platform mounted above the leaves and adapted to traverse the slab during the conditioning process.

5 Claims, 11 Drawing Figures



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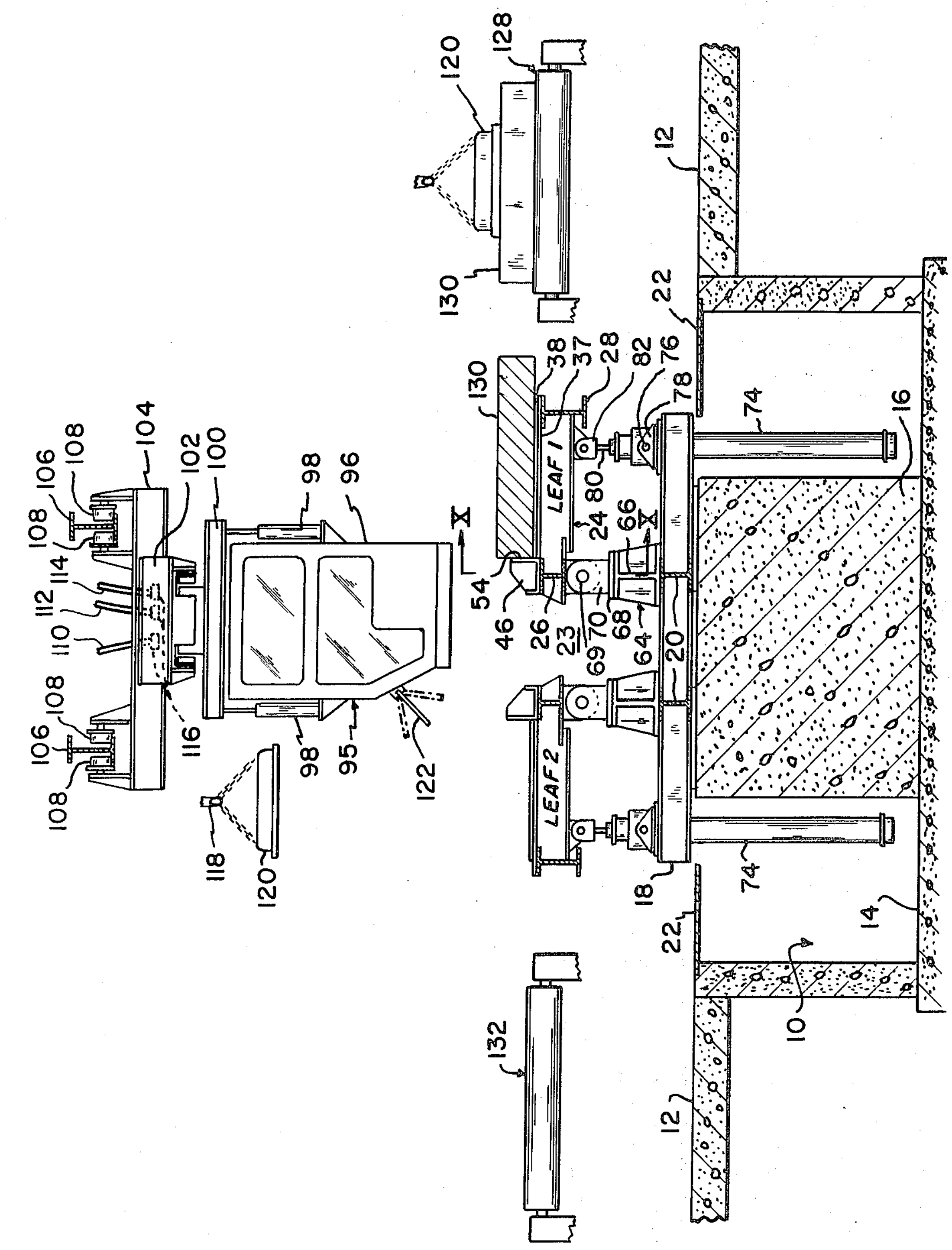

Fig. 1

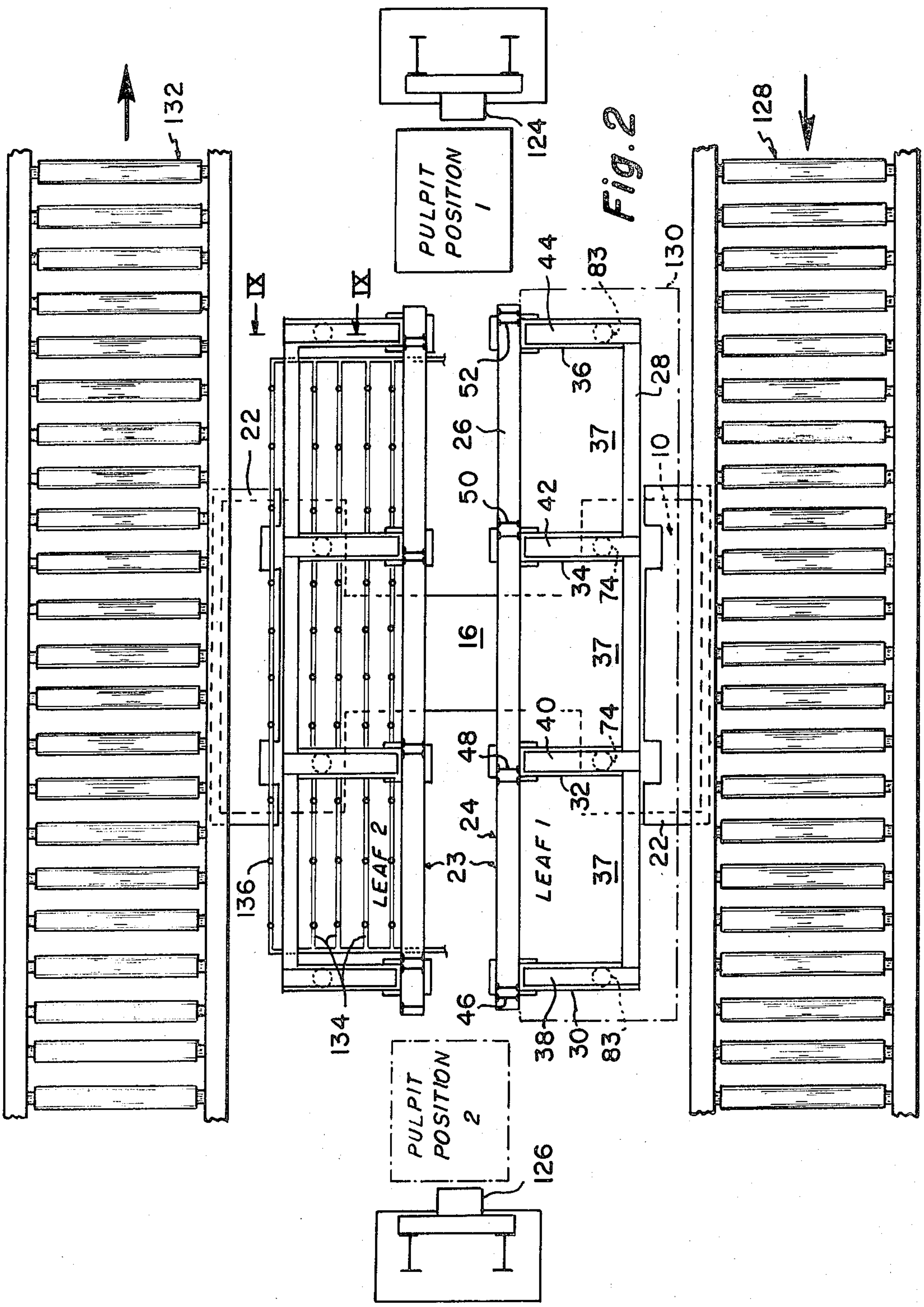
PULPIT POSITION 1
PULPIT POSITION 2
LEAF 1
LEAF 2
IX
IX
10
16
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Fig. 2

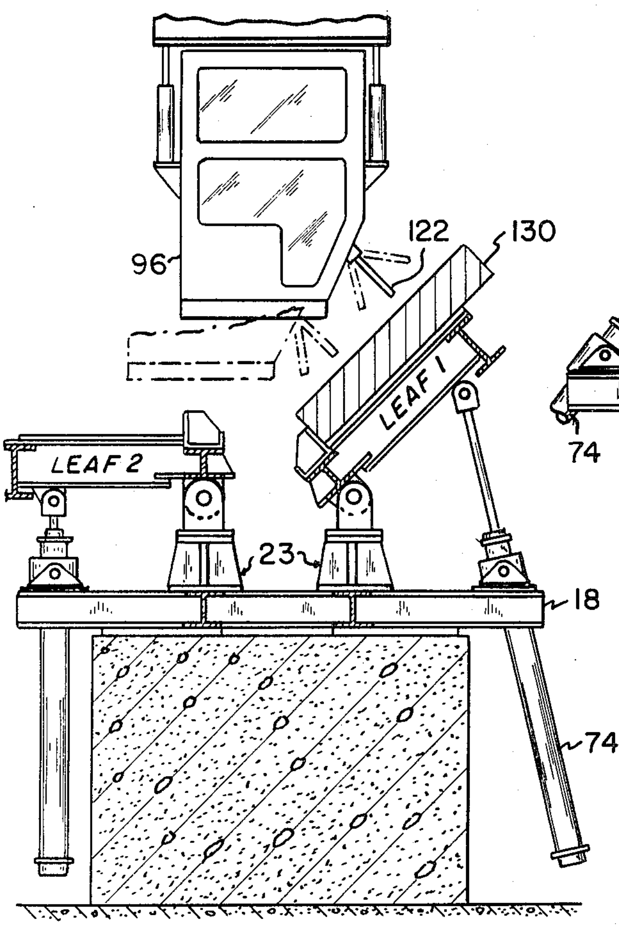

Fig. 3

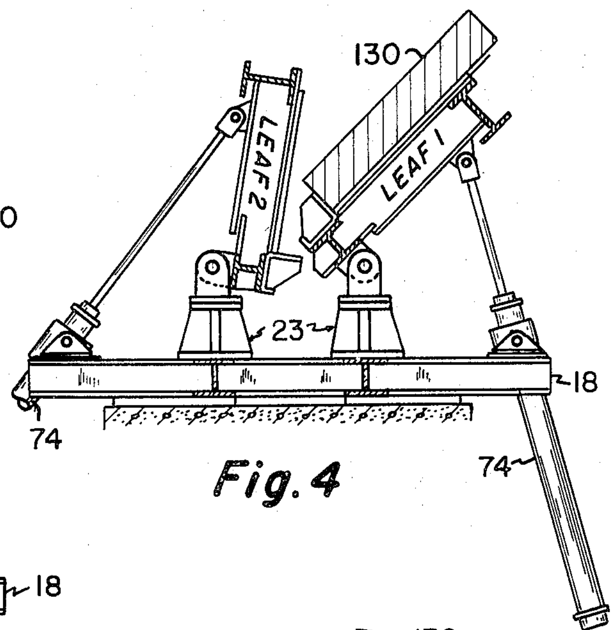

Fig. 4

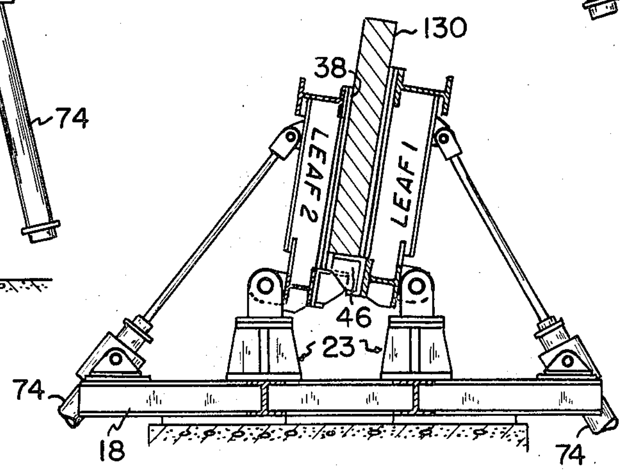

Fig. 5

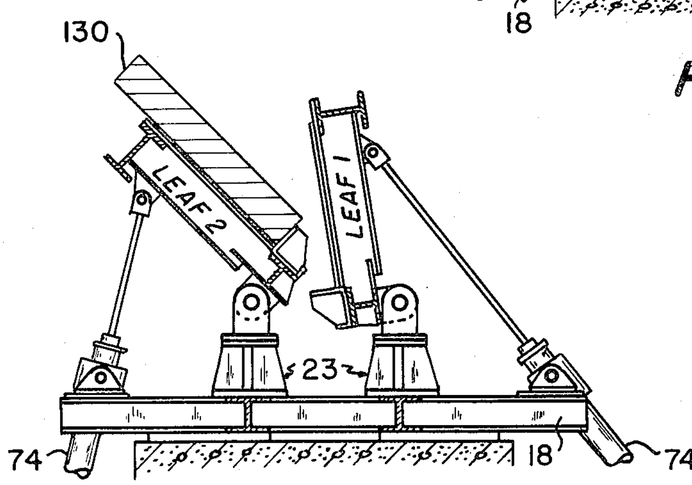

Fig. 6

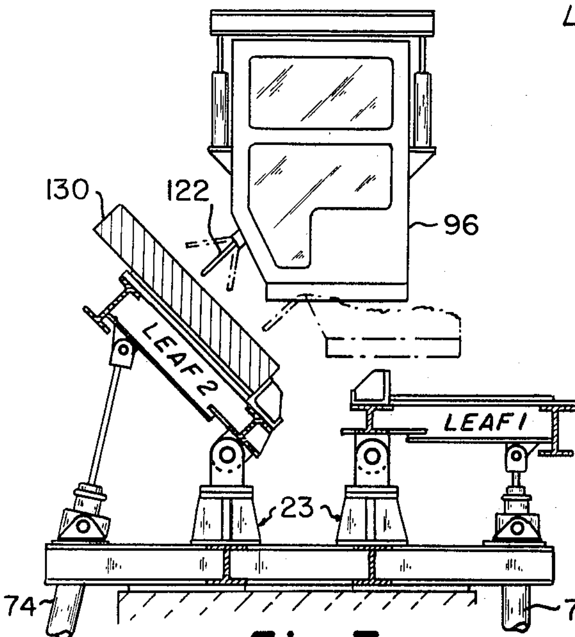

Fig. 7

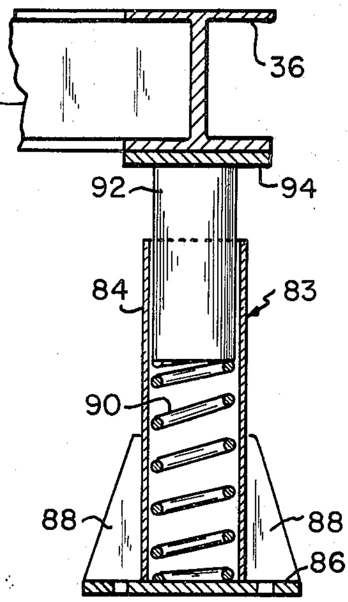

Fig. 9

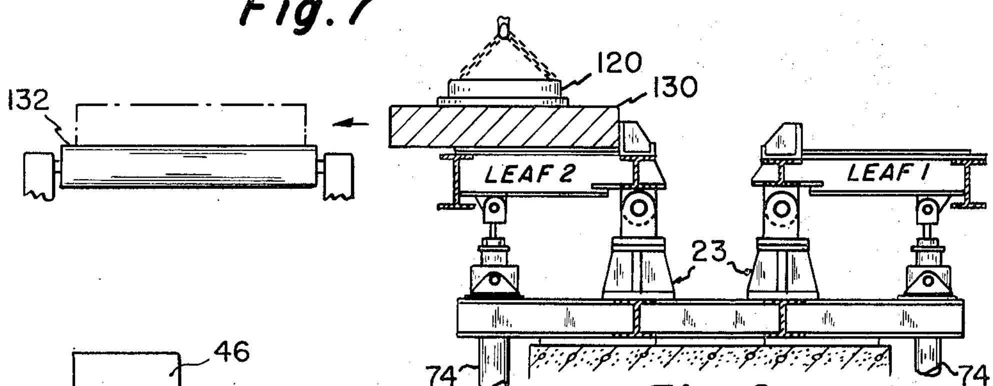

Fig. 8

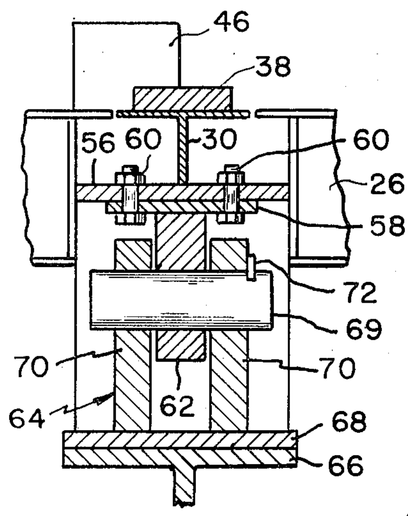

Fig. 10

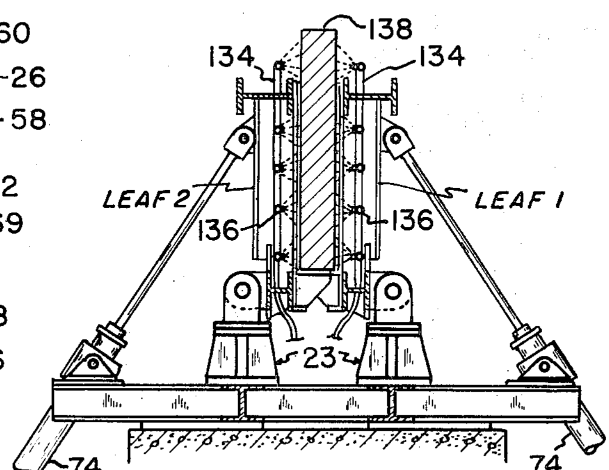

Fig. 11

METAL SLAB CONDITIONING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the conditioning of metal slabs; more particularly to a system for conditioning the surfaces of metal slabs and method of operation therefor.

2. Description of the Prior Art

With the increased demand for metal products having close tolerances in both chemical and physical properties, manufacturers have found it necessary to condition metal in the semi-finished state in order to insure its suitability for further processing; otherwise, excessive amounts of in-plant scrap metal are generated. The conditioning process is directed largely to the removal of defects in the surface of metal slabs, billets and the like, which defects, if not corrected, can cause fouling of equipment in subsequent rolling operations. These defects can also produce more serious physical defects in the metal processed in such rolling operations, making it unacceptable for shipment.

Typical of the problems associated with surface conditioning of metals are those presented in the manufacture of steel. The primary technique for removing surface defects in semi-finished steel slabs, billets and blooms is by scarfing. Scarfing consists of the application of oxygen and gas to the steel surface, usually by a torch, to oxidize the steel and thereby generate elevated temperatures that cause the oxidized product and adjacent steel to become liquid, which is then blown away. To a lesser extent, surface conditioning of steel is also carried out by grinding, particularly on stainless steel, and by hand chipping.

Traditionally, scarfing has been a manual operation performed in a mill yard by a workman standing on a steel slab and manipulating a scarfing torch. This means, of course, that the slab must be cooled sufficiently to permit the workman to walk upon it. When one surface is completed, the slab is lifted with a chain or magnet held by an overhead crane and by some means turned over and lowered on the scarfed side; the manual scarfing process is then repeated. Slab weights have recently reached up to 40 tons or more and have thus made this turnover operation dangerous to workmen nearby. Moreover, scarfing produces heat and noxious fumes, thereby presenting health hazards to the workmen involved in the scarfing operation. Also the arduous nature of the operation rapidly fatigues the worker and reduces his productivity.

More recently, automatic scarfing units have been installed in some plants in an in-line relationship with rolling mills. Automatic scarfing units consist of a number of scarfing torches so designed that they form a pass on the mill; accordingly, steel may be scarfed in the hot condition. However, scarfing is virtually indiscriminate with automatic scarfing machines and may result in reductions in metal yield up to 3–4 percent, depending on the size of slab or bloom and the depth of scarfing.

Other attempts have been made to mechanize discriminate scarfing operations; for example, a billet scarfing machine is shown in U.S. Pat. No. 3,176,971. That patent, however, contains no suggestion of a solution for the problems associated with scarfing heavy slabs and, in general, discloses a machine that lacks the versatility required for slab scarfing.

The present invention overcomes the disadvantages and objections associated with present metal surface conditioning equipment and methods. Not only are more efficient operating procedures afforded with the present invention, but also personnel safety hazards are markedly reduced.

SUMMARY OF THE INVENTION

The present invention provides a slab conditioning system comprising: a base, a pair of independently rotatable leaves each adapted to support a slab, each of the leaves being pivotally mounted to the base to rotate in a direction toward the other for transferring the slab from one of the leaves to the other; means for independently rotating the leaves; and a slab conditioning tool platform rotatably mounted above the leaves and adapted for translatory motion with respect to the leaves. Preferably, the translatory motion of the tool platform includes longitudinal, lateral and vertical motion with respect to a line parallel with and central of the pivotal axes of the leaves.

Further, the present invention preferably provides that each of the leaves is rotatable from a horizontal position through more than 90° in a direction toward the other leaf and that the leaves each include a frame and slab stop means extending perpendicularly from the portion of the frame adjacent to its pivotal mounting to the base. The slab stop means of each of the leaves are preferably positioned to cooperate with the other in the transfer of the slab. Also, the present invention preferably provides that the means for rotating the leaves comprises lift cylinders operably connected between the base and each of the leaves.

The slab conditioning tool platform of the present invention preferably depends from an overhead support means positioned in a vertical plane central of the pivotal axes of the leaves. Preferably, the platform is adapted for at least 270° of rotation.

The present invention further provides, in a slab conditioning system, the improvement comprising: a base; a pair of independently rotatable leaves each adapted to support a slab, each of the leaves being pivotally mounted to the base to rotate in a direction toward the other for transferring the slab from one of the leaves to the other; and means for independently rotating the leaves. Preferably, liquid spray means are mounted on the leaves and adapted to discharge the spray simultaneously against the top and bottom surfaces of the slab being supported in an upright position by the leaves.

The present invention further provides a method for conditioning metal slabs comprising: (A) delivering a slab to a first rotatable slab support means from a first direction; (B) rotating the first slab support means to incline the top surface of the slab; (C) longitudinally traversing the top surface with a conditioning tool to selectively condition the top surface; (D) transferring the slab from the first slab support means to a second rotatable slab means; (E) rotating the second slab support means to incline the bottom surface of the slab; (F) longitudinally traversing the bottom surface with the conditioning tool to selectively condition the bottom surface; and (G) discharging the slab from the second slab support means in a direction opposite from the first direction.

Other advantages of the present invention will become apparent from a consideration of the following detailed description taken with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view, partially in section, of the present invention;

FIG. 2 is a plan view of the present invention;

FIG. 3 is a partial elevational view showing a slab in a raised position and the slab conditioning tool platform in working locations;

FIGS. 4–6 are partial elevational views showing the sequence of movement to accomplish slab turnover;

FIG. 7 is a partial elevational view showing a slab in a raised position on the opposite leaf and the slab conditioning tool platform in working locations;

FIG. 8 is a partial elevational view showing a slab removal technique;

FIG. 9 is an enlarged sectional view taken along line IX—IX of FIG. 2;

FIG. 10 is an enlarged sectional view taken along line X—X of FIG. 1; and

FIG. 11 is a partial elevational view showing a slab being supported in an upright position and quenched.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2, there is shown an I-shaped pit **10** formed in the floor **12** of a mill area. Pit **10** is encased in concrete and has a concrete floor **14**. A rectangular concrete bridge **16** having a top surface level with mill floor **12** spans pit **10** across the midpoint of the neck of the "I." An elongated rectangular base **18** is supported on bridge **16** and the portions of the mill floor **12** extending on either side of bridge **16**. Base **18** is formed of heavy gauge stock and includes a pair of central H-beams **20** extending longitudinally of base **18**. The side edges of base **18** overhang bridge **16**. The open portions of pit **10** on each side of bridge **16** are enclosed by removable floor plates **22** extending from the mill floor **12** to the overhanging side edges of base **18**.

A slab handling unit, generally designated by the reference number **23**, is mounted on base **18**. Slab handling unit **23** includes a pair of rotatable leaves. For convenience herein, these leaves will be referred to as "leaf **1**" and "leaf **2**" and are so designated on the drawings. Since leaf **1** and leaf **2** are of identical construction (except for certain differences which will be noted), only leaf **1** will be described.

Leaf **1** includes a frame **24** having a pair of spaced longitudinal frame members **26** and **28** formed from heavy gauge I-beams. Frame members **26** and **28** are connected by transverse frame separators **30, 32, 34** and **36**, also of I-beam configuration. Frame **24** supports top plates **37**. Mounted on top plates **37**, longitudinally above frame separators **30, 32, 34** and **36**, respectively, are wear plates **38, 40, 42** and **44**. Wear plates **38, 40, 42** and **44** are designed to support a slab resting on leaf **1**.

Offset from the centerline of each of frame separators **30, 32, 34** and **36** and mounted on frame member **26** (nearest the centerline of base **18**) are aligned slab stops **46, 48, 50** and **52**. Slab stops **46, 48, 50** and **52** are formed of heavy gauge stock having uneven sides; each stop has a pair of spaced, transverse stiffeners joining the sides of the stop, the long side of which forms the face **54** of each stop. It should be noted that the slab stops of leaf **2** are also mounted in offset fashion but on opposite sides of the centerline of their associated frame separators from the slab stops on leaf **1**. This oppositely offset mounting of the slab stops permits them to cooperate when leaves **1** and **2** are brought into facing relationship.

Leaf **1** is pivotally mounted to base **18** at four points along the edge of leaf **1** nearest the centerline of base **18**. These mounting points coincide with the respective junctures of frame separators **30, 32, 34** and **36** with frame member **26**. Since the structure of the mounting points is identical, only the one associated with frame separator **30** will be described and that by reference to FIG. **10**. Frame separator **30** comprises an I-beam with a portion of the lower flange and web cut away as shown in FIG. **1**. A horizontal plate **56** is connected to the remaining vertical web of frame separator **30**. Mounting plate **58** is connected to the underside of plate **56** by means of bolts **60**. A pivot plate **62** having an opening (not shown) therethrough depends vertically from mounting plate **58**. The opening in pivot plate **62** carries a bronze bushing (not shown). Mounted on base **18** is a pedestal **64** which includes an H-beam **66** and a mounting plate **68** secured thereto. A pair of upright, spaced, parallel plates **70** are connected to mounting plate **68** and are arranged on either side of pivot plate **62**. Plates **70** each have an opening (not shown) aligned with the opening in pivot plate **62**. A shaft assembly **69** is inserted into the aligned openings in plates **70**, pivot plate **62** and/or the bushing carried by pivot plate **62**. Shaft assembly **69** is fixed in place by keeper pin **72**. Thus, pivot plate **62** (and thus leaf **1**) is rotatable about shaft assembly **69**.

Rotation of leaf **1** is accomplished by means of a pair of upright hydraulic lift cylinders **74** positioned beneath the two central frame separators **32** and **34**. Each cylinder **74** is pivotally mounted to the overhanging portion of base **18** at the upper portion of the cylinder barrel; the cylinder barrel extends through an opening in base **18** and into pit **10**. The pivotal mounting of each cylinder **74** includes lugs **76** extending from opposite sides of the cylinder barrel and mounted in trunnions (not shown) carried by a pair or upright brackets **78** mounted to base **18**. The ends of piston rods **80** associated with cylinders **74** are clevis mounted to the underside of their corresponding frame separators **32** and **34** as shown diagrammatically at **82**. When cylinders **74** are actuated, the ends of piston rods **80** pivot about their mounting points to leaf **1** as it moves from the normal horizontal position shown in FIG. **1** toward the vertical position. At the same time, cylinders **74** pivot in their mountings to base **18** so that the lower ends of cylinders **74** move within pit **10** in an arc away from bridge **16**. The pivotal mounting of cylinders **74** permits them to move leaf **1** through the vertical to an angle in excess of **90** degrees depending upon the length of the cylinders.

Located at the two outboard corners of leaf **1** and in longitudinal alignment with cylinders **74** are bumper assemblies **83**. As shown in FIG. **9**, each bumper assembly **83** includes an upright tube **84** mounted to base **18** by means of mounting plate **86** and supported by brackets **88**. A coiled spring **90** is inserted into tube **84**. Spring **90** is capped by tubular bumper **92** having a pad

94 closing the top thereof. Bumper **92** is dimensioned to slide within tube **84** and normally extends above the top of tube **84**. The corner of leaf **1** is supported by pad **94**. Bumper assemblies **83** act as shock absorbers when leaf **1**, supporting a slab, is lowered to the horizontal position.

Depending upon local conditions, the slab handling unit **23** may be situated under a crane girder or on a centerline of two adjacent buildings in space usually considered "dead" because of the crane hook approach. In the latter situation, the slab handling unit **23** could be used as a means for transferring slabs from one building to another. In any event, a workpiece conditioning tool platform, generally designated by the reference numeral **95**, is suspended above slab handling unit **23** and adapted to traverse the approximate longitudinal centerline of base **18**.

As shown in FIG. **1**, workpiece conditioning tool platform **95** includes an enclosed, air-conditioned pulpit **96** suspended above slab handling unit **23**. Pulpit **96** is intended to carry an operator and suitable controls to perform the functions described hereinafter. Pulpit **96** is movable vertically by means of a pair of hydraulic or electric cylinders **98** mounted between pulpit **96** and pulpit support member **100**. Other suitable means may be employed to provide vertical motion to the pulpit. Pulpit support member **100** is rotatably mounted for at least 180°, but preferably 270°, of rotation by well known means to a carriage member **102**. Carriage member **102**, in turn, is suspended from transverse rails **104** and able to move laterally therealong by means of suitable rollers (not shown). Rails **104** are suspended from longitudinal girders **106** and adapted for longitudinal movement thereon by means of rollers **108**. Electric power, oxygen and fuel are supplied to pulpit **96** through flexible conduits **110**, **112** and **114**, respectively, each having swivel means **116** therein. Conduits **110**, **112** and **114** may be fed from reels or festooned above girders **106**. FIG. **1** also shows an overhead crane hook **118** suspending an electric magnet **120** at the closest possible relative point of approach to pulpit **96**. Pivotally mounted at the lower portion of pulpit **96** is a workpiece conditioning tool **122**, in this case depicted as a scarfing torch. Workpiece conditioning tool **122** is designed to be manipulated and controlled as desired by the operator in pulpit **96**.

By reference to FIGS. **1–7**, a typical operating sequence of the present invention will now be described. The operation begins with the pulpit in Position **1** (see FIG. **2**), well clear of slab handling unit **23** and any length slab which might be supported thereon for conditioning. Pulpit Position **1** is adjacent control station **124** which has the controls necessary to actuate slab handling unit **23**. Control station **124** is designed to permit the operator to manipulate the controls without leaving his station in pulpit **96**. An identical control station **126** is located at the opposite side of slab handling unit **23**, adjacent Pulpit Position **2**.

Metal slabs requiring conditioning are delivered to slab handling unit **23** on delivery table **128**. Movement of slabs on delivery table **128** may be facilitated by rollers as shown or other suitable means. With leaves **1** and **2** in the horizontal positions shown in FIG. **1**, magnet **120** lifts a first slab **130** from delivery table **128** and places it upon leaf **1** in a horizontal position with a longitudinal edge abutting faces **54** of slab stops **46**, **48**, **50** and **52**. Instead of the crane and magnet shown, other suitable means may be employed to charge slabs to leaf **1** including platens having rollers or air bearings mounted thereon.

The operator next actuates lift cylinders **74** of leaf **1** to raise slab **130** to a position where it is inclined at about a 45° angle (see FIG. **3**). The operator then rotates pulpit **96** to a position where conditioning tool **122** is substantially perpendicular to the inclined top surface of slab **130** (as shown in solid lines in FIG. **3**). The operator will then control pulpit **96** to traverse the length of slab **130** approximately above the centerline of base **18**. As pulpit **96** traverses, the operator is able to maintain the conditioning tool generally in the same relative position to the inclined surface of slab **130** by manipulating his controls of the position of (i) pulpit lift cylinders **98**, for vertical movement and (ii) carriage member **102**, for lateral movement. The maintenance of this relative position is especially important in conditioning operations such as scarfing, grinding, inspection and chipping which require close visual observation of the slab surface by the operator. The operator is further aided by the pivotal mounting of conditioning tool **122** which enables him to move tool **122** in the range shown in broken lines in FIG. **3**.

Another unique advantage gained by the present invention is attributable to performing the conditioning operation while the slab is inclined. With this arrangement, the residue of the conditioning operation (e.g. the slag formed during scarfing) runs down the surface of the slab and drops onto the floor below where it can be conveniently collected. Thus, a clean slab surface is always presented for the operator's inspection.

When the conditioning of the top surface of slab **130** is completed by making one or a multiple number of passes across the face of the slab, the operator continues the traverse of pulpit **96** until it reaches either Pulpit Position **1** or Pulpit Position **2**. These positions are well clear of slab handling unit **23** and any slab thereon. The operator actuates lift cylinders **74** of leaf **2** to rotate leaf **2** toward leaf **1** until leaf **2** passes through the vertical and reaches a position about 100° from its original horizontal position (see FIG. **4**). While leaf **2** is being rotated, the operator keeps leaf **1** in its inclined position. Next, the operator actuates lift cylinders **74** of leaf **1** to rotate it toward leaf **2**. When leaves **1** and **2** are substantially parallel (see FIG. **5**), the top surface of slab **130** is very close to the wear plates **38**, **40**, **42** and **44** of leaf **2**; and practically all of the weight of slab **130** is being borne by slab stops **46**, **48**, **50** and **52** of leaf **1**. It should be noted that in this position, the slab stops of leaf **1** are elevated slightly above the slab stops of leaf **2**. Also, the offset positions of the slab stops on the facing leaves permit them to overlap and thereby makes possible the close relationship of the top surface of slab **130** to the wear plates of leaf **2**. This feature affords a relatively "soft" transfer of slab **130** to leaf **2** as next described.

The operator then actuates the lift cylinders of both leaf **1** and **2** to cause them to move together toward leaf **2** while maintaining a substantially parallel relationship. When the leaves are about vertical, the front surfaces **54** of the slab stops of both leaves will be about horizontal, thereby permitting the slab stops of leaf **2** to share the support of slab **130**. As simultaneous rotation of the leaves continues, the slab stops of leaf **2** raise above the slab stops of leaf **1** and assume the entire burden of supporting slab **130**. In this condition, leaf **1** is serving only to steady slab **130.** When leaf **1** has rotated slightly more than **90** degrees from its original horizontal position, the operator stops rotation of leaf **1** but continues the downward rotation of leaf **2** until the bottom surface of slab **130** is inclined at an angle of about 45° (see FIG. **6**). At the same time, the operator returns leaf **1** to its original horizontal position for receiving a new slab.

The operator then rotates the pulpit 180° to place conditioning tool **122** into correct position as shown in FIG. **7** and traverses the length of slab **130,** performing a conditioning operation on the bottom surface of slab **130** as described above. When that conditioning operation is complete, the operator continues the traverse of pulpit **96** until it reaches either Pulpit Position **1** or Pulpit Position **2.** There, the operator actuates controls at control station **124** or **126** to continue the rotation of leaf **2** until it reaches the horizontal position (see FIG. **8**). Magnet **120** lifts slab **130** from leaf **2** and places it on exit table **132** of similar construction to delivery table **128.** Slab **130** is then moved away from slab handling unit **23** for further processing. The operator may then repeat the entire operation just described with respect to a second slab. It should be mentioned that one or more cranes may be used to carry magnet **120** and these may be (an most likely are) operated independently of pulpit **96.** Thus, when the operator of slab handling unit **23** has completed the conditioning of a first slab, a second slab already will have been placed into position on leaf **1.** Thus, the time required to load and unload slabs from slab handling unit **23** is essentially integral with operating time.

It may be seen from the foregoing that the operator in pulpit **96** is able to perform a discriminate scarfing operation, for example, on a hot slab. Further, he can carry out the operation without being subject to heat and noxious fumes and can turn the slabs without a dangerous lifting operation as is now commonly practiced. Further, he is not subjected to fatigue of heavy manual work, thus increasing his personal productivity. Further, because the tool is mechanically mounted rather than manually held as in present practice, he can employ larger, heavier tools thus enhancing personal productivity.

A further advantage may be realized with the slab handling unit of the present invention if, for example, it is located near the run-off table of a continuous slab caster. Ordinarily, after slabs emerging from a continuous caster are sheared, they are stacked horizontally on a rail car and moved to a yard for air cooling. This cooling operation may require several days and because of the different cooling rate experienced by a slab surface directly exposed to air compared with a surface abutting another hot slab, "bowing" of the slabs often occurs. A bowed slab is difficult to process and sometimes requires further treatment to make it usable.

Accordingly, slab handling unit **23** may be employed as a quenching unit for hot slabs. As shown in FIGS. **2** and **11,** both leaves of slab handling unit **23** may be fitted with a series of spaced water pipes **134** having jet devices **136** of any well known type mounted thereon at spaced intervals. In this case, top plates **37** and some of the underlying longitudinal and transverse supports would be omitted. As shown in FIG. **11,** a slab **138** is raised to the vertical position by the cooperative rotation of leaves **1** and **2** in the manner described above. In this position, jet devices **136** point directly at the large flat surfaces of slab **138** and discharge water sprays uniformly over these surfaces. By subjecting both large surfaces of slab **138** to quenching liquid delivered at equal rates and for equal time periods, equal cooling is enjoyed and bowing of the slab is reduced or eliminated.

What is claimed is:

1. The combination comprising:

A. slab handling apparatus including:

i. a base;

ii. a pair of independently rotatable leaves each adapted to support a slab, each of said leaves being pivotally mounted to said base to rotate in a direction toward the other for transferring said slab from one of said leaves to the other;

iii. means for independently rotating each of said leaves from a horizontal position through more than 90° in a direction toward the other leaf, said leaf rotating means being adapted for selectively positioning each of said leaves in an inclined orientation;

B. an enclosed conditioning tool platform mounted for rotation above said leaves and having a slab conditioning tool projecting therefrom; and

C. means supporting said slab conditioning tool platform, said supporting means including means for imparting to said slab conditioning tool platform longitudinal, vertical and lateral motion with respect to a line parallel with and central of the pivotal axes of said leaves for positioning said slab conditioning tool in the same relative position with respect to the surface of said slab supported in said inclined position on either of said leaves as said tool moves thereacross, whereby said slab conditioning tool is selectively positionable with respect to said surface of said slab supported in said inclined position on either of said leaves.

2. The combination recited in claim **1** wherein:

said means for rotating said leaves comprises lift cylinders operably connected between said base and each of said leaves.

3. The combination recited in claim **1** wherein:

said leaves include slab stop means extending from each of said leaves and being positioned to cooperate with each other in said transfer of said slab.

4. The combination recited in claim **1** wherein:

said slab conditioning tool platform depends from an overhead support means positioned in a vertical plane central of the pivotal axes of said leaves.

5. The combination recited in claim **1** wherein:

said slab conditioning tool platform is adapted for at least 270° of rotation, whereby said slab conditioning tool may be selectively positioned with respect to said slab supported in said inclined position on either of said leaves by 180° of rotation of said slab conditioning tool platform.

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