Feb. 6, 1968 L. S. KAZEBEE ETAL 3,367,162

APPARATUS FOR REDUCING SLAB WIDTH

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FIG. 1

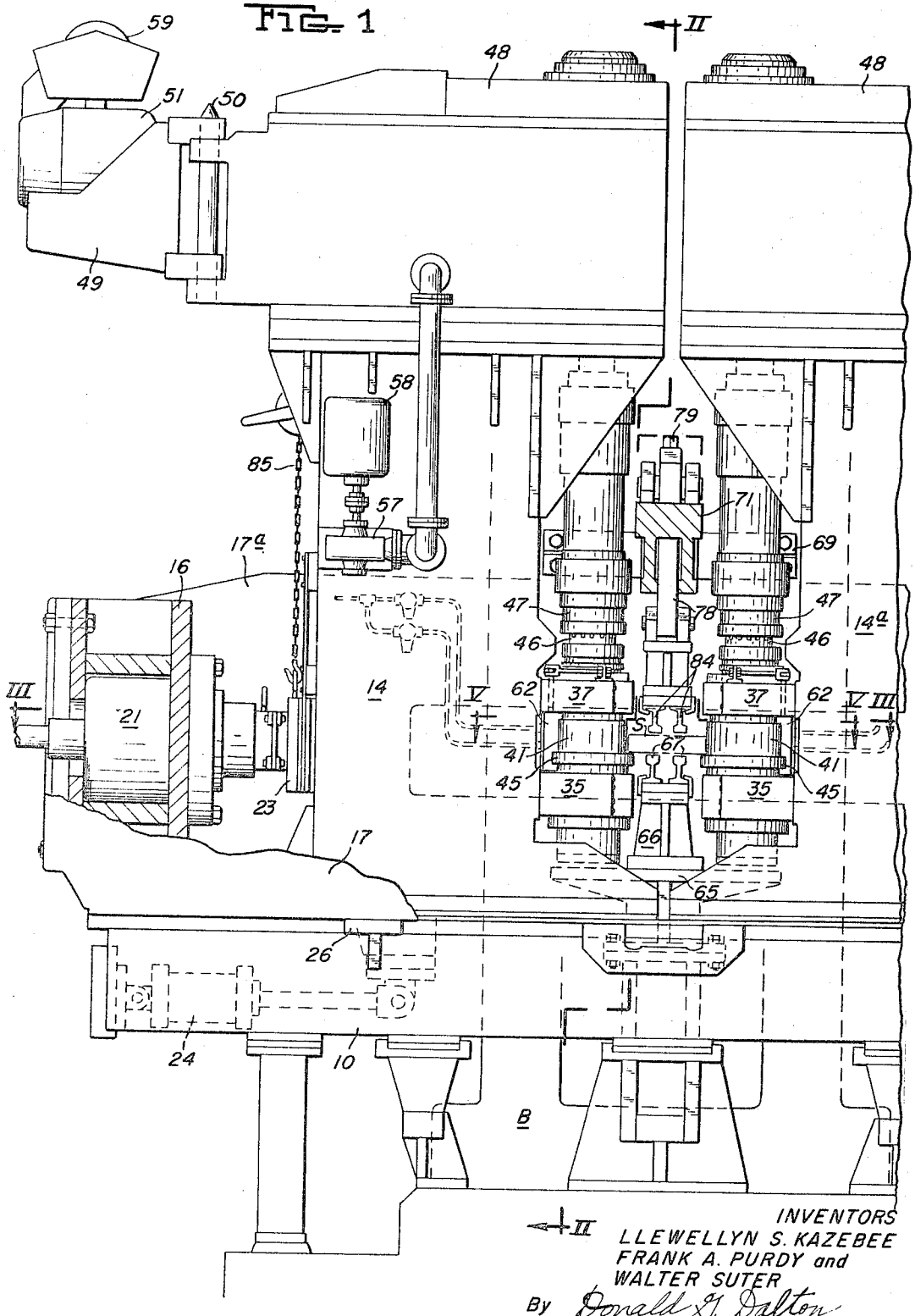

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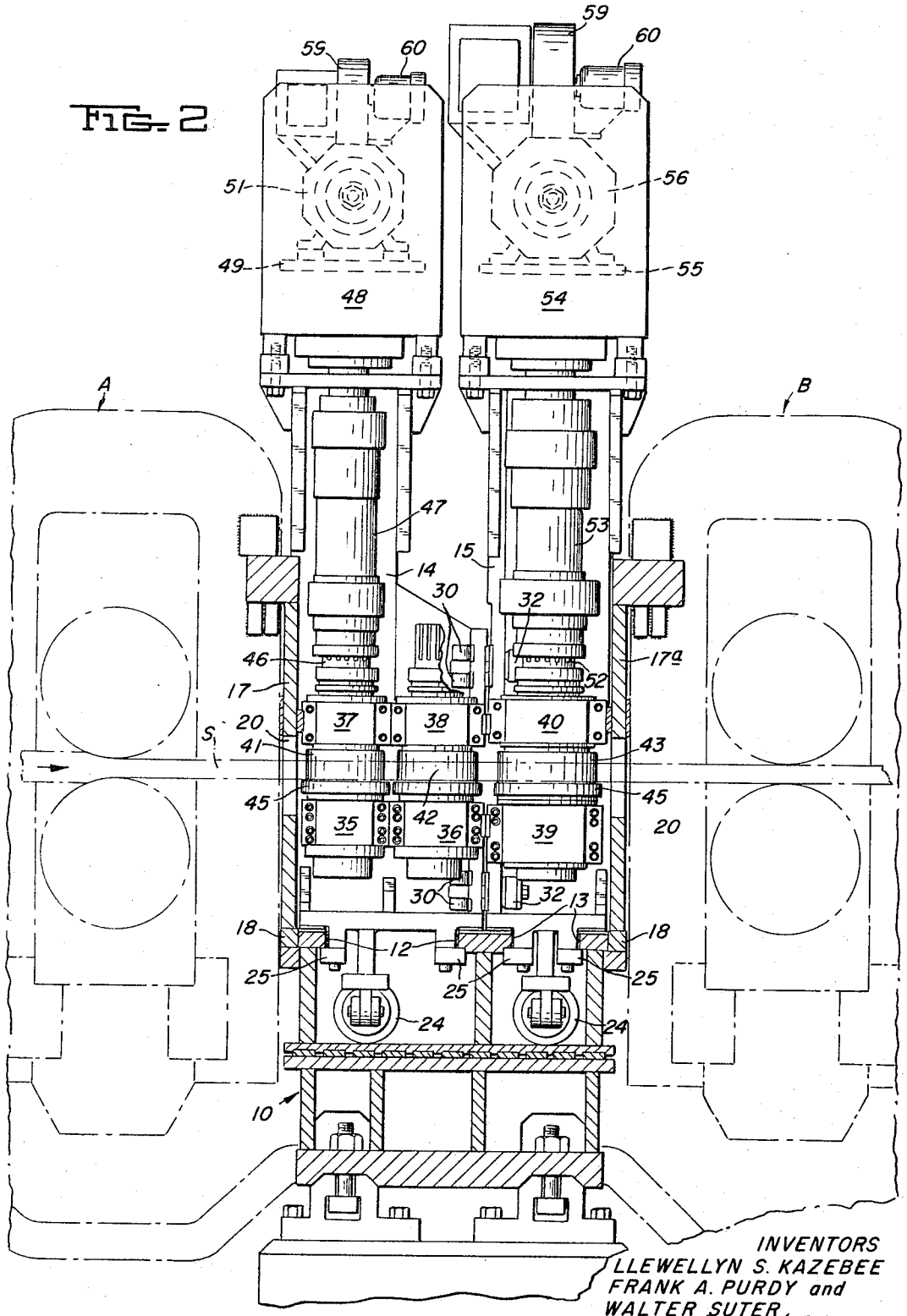
FIG. 2



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APPARATUS FOR REDUCING SLAB WIDTH

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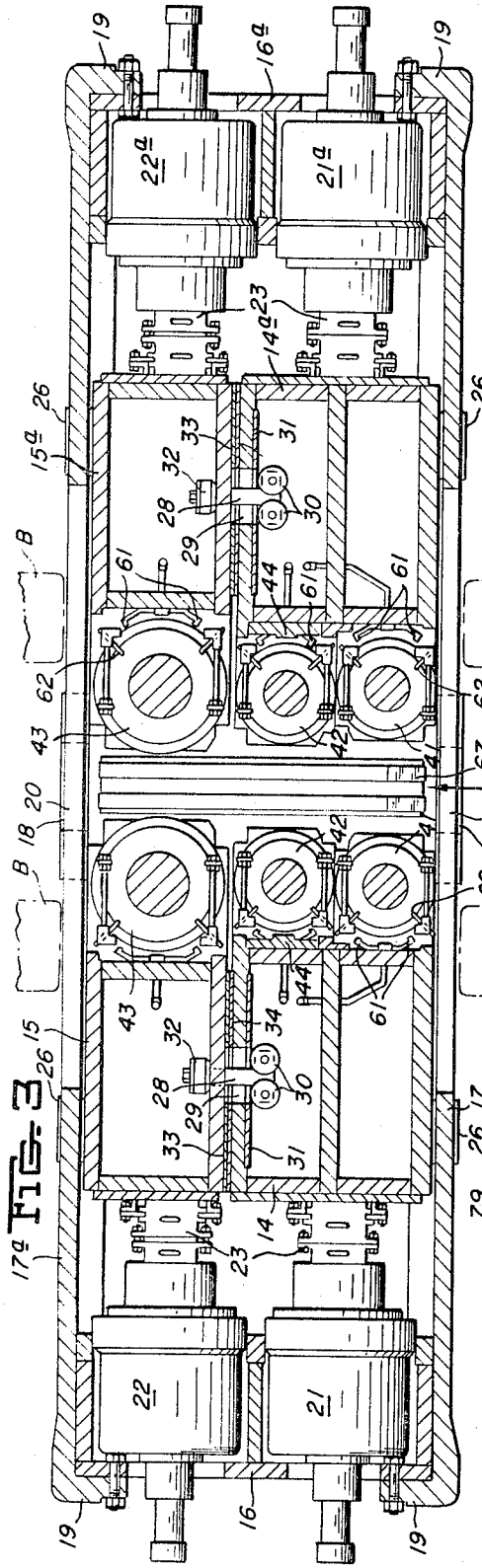

FIG. 3

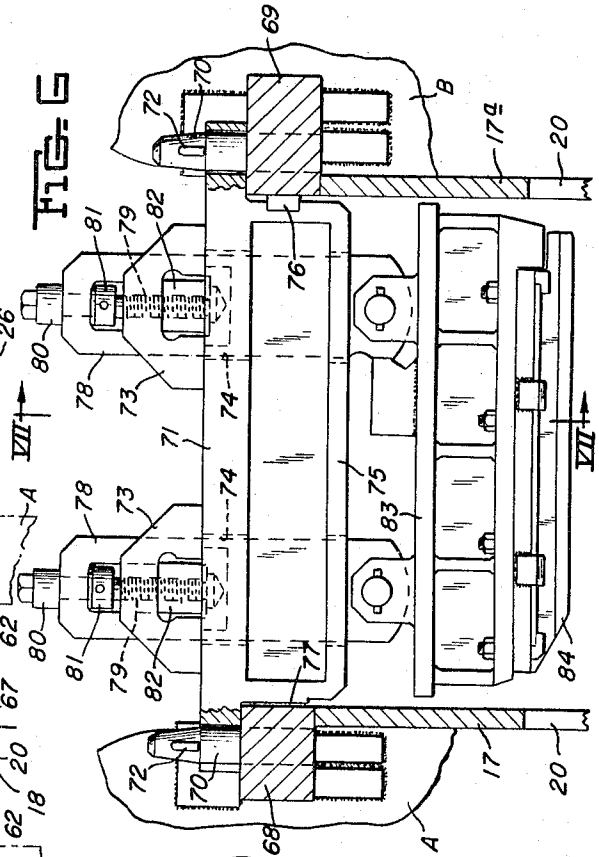

FIG. 5

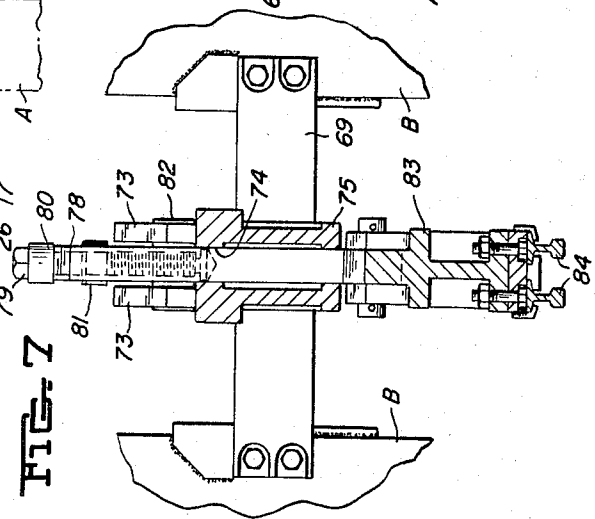

FIG. 7

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APPARATUS FOR REDUCING SLAB WIDTH

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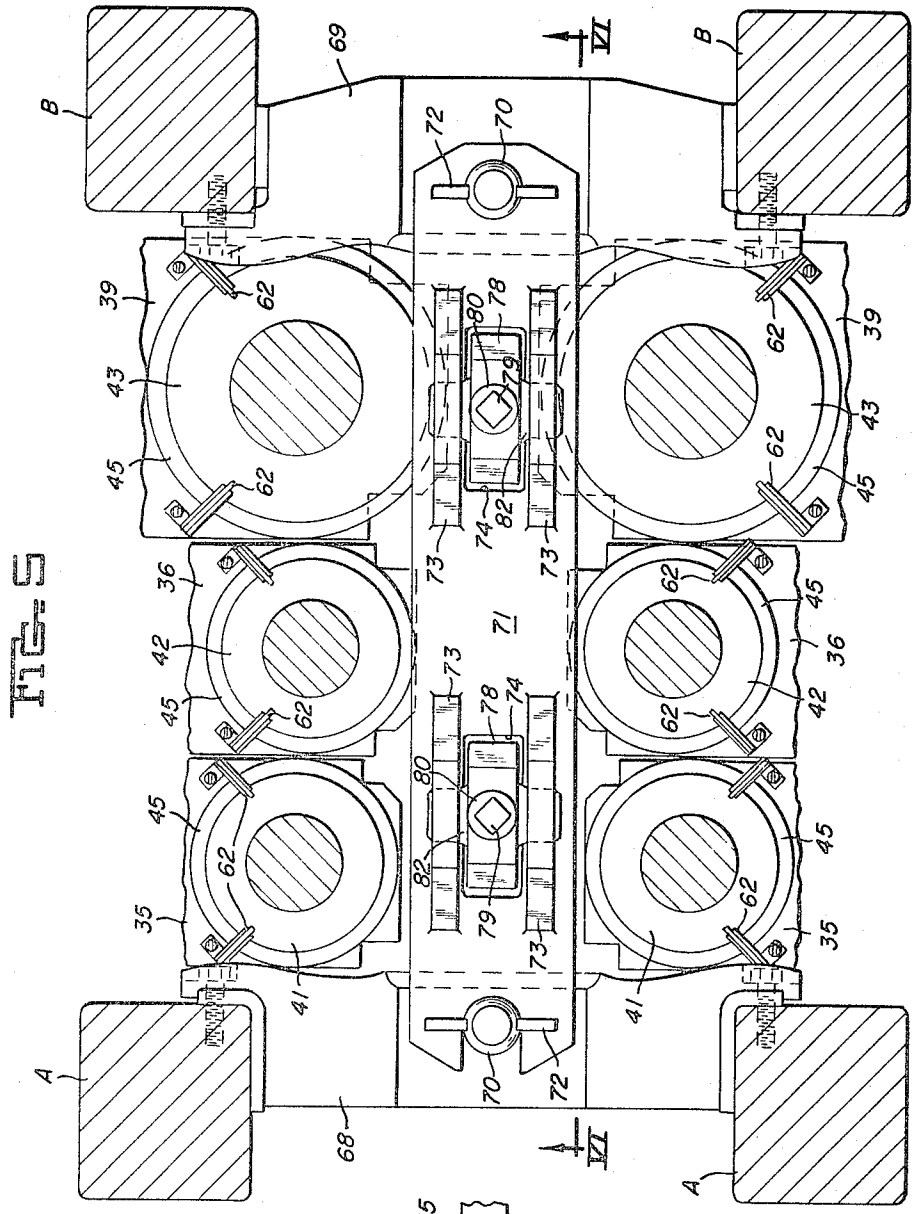

FIG. 5

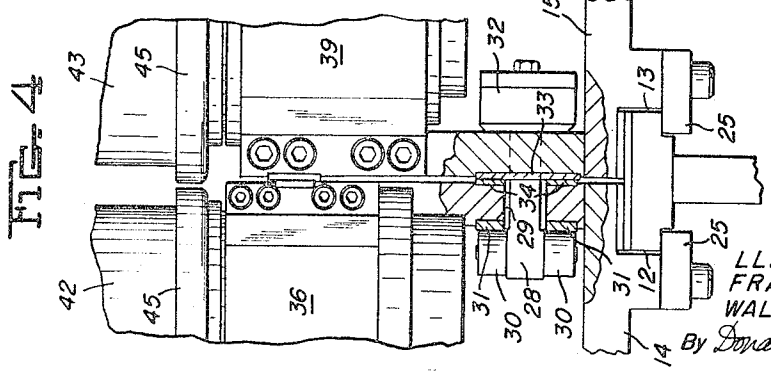

FIG. 4

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APPARATUS FOR REDUCING SLAB WIDTH

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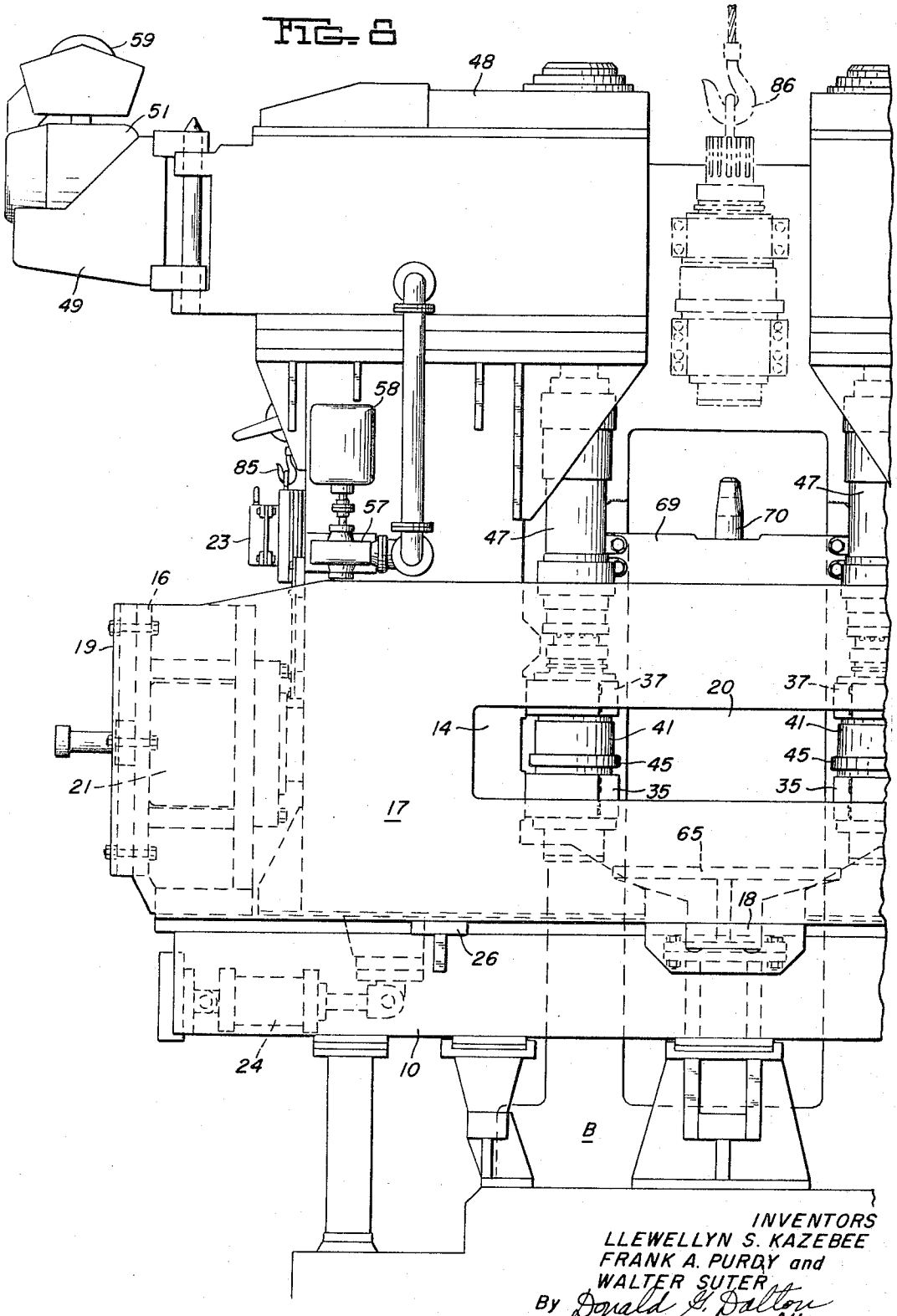
FIG. 8



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APPARATUS FOR REDUCING SLAB WIDTH

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Filed Apr. 7, 1965, Ser. No. 446,221
14 Claims. (Cl. 72—205)

ABSTRACT OF THE DISCLOSURE

An edge-rolling mill for hot steel slabs formed by a continuous casting process. Mill includes a plurality of vertical sets of rolls situated between two conventional horizontal roll stands. The vertical rolls reduce the slab width quite drastically, while assisting the horizontal rolls in maintaining the slab under tension.

This invention relates to an improved edge-rolling mill for reducing the width of steel slabs or the like.

An object of the invention is to provide an improved edge-rolling mill which operates in conjunction with conventional horizontal roll stands to reduce the total section of a slab in one closely coupled operation without turning or stopping the slab.

A further object is to provide an improved edge-rolling mill particularly adapted for reducing the width of slabs formed by a continuous casting process, where it is desirable to reduce the slab width quite drastically with the slab under tension before it becomes too cool.

A more specific object is to provide an improved edge-rolling mill which includes at least three sets of rolls journaled on vertical axes to reduce a slab width in steps and apply tension to the slab, and means for applying pressure to the rolls and controlling their spacing.

In the drawings:

FIGURE 1 is an end elevational view partly in section of our edge-rolling mill taken from the entry end and with the front tension plate broken away;

FIGURE 2 is a longitudinal vertical section on line II—II of FIGURE 1;

FIGURE 3 is a horizontal section on line III—III of FIGURE 1;

FIGURE 4 is a vertical sectional view on a larger scale to show one of the tension slide assemblies;

FIGURE 5 is a horizontal section on a larger scale on line V—V of FIGURE 1;

FIGURE 6 is a vertical section on line VI—VI of FIGURE 5;

FIGURE 7 is a vertical section on line VII—VII of FIGURE 6; and

FIGURE 8 is an end elevational view similar to FIGURE 1, but including the front tension plate, and showing how we remove and install the rolls.

Our rolling mill includes a stationary base frame **10** fabricated of steel plates rigidly fixed to one another, as by welding. The plates at the top of the frame define an opposed pair of relatively wide transverse slideways **12** and an opposed pair of narrow slideways **13** (FIGURE 2). We mount a first opposed pair of slide housings **14** and **14***a* on the base frame **10** for transverse sliding movement along the respective slideways **12** and a second opposed pair of slide housings **15** and **15***a* for similar movement along the respective slideways **13**. The base frame **10** carries an opposed pair of slidably supported upstanding ram crossheads **16** and **16***a* at its outer ends (FIGURE 3). Front and rear tension plates **17** and **17***a* extend across the entry and exit sides of the mill, spanning the two crossheads and the space therebetween. The mid portions of the tension plates carry downwardly projecting

keys **18** which are received in corresponding keyways in the base frame **10**. The ends of the tension plates have integral flanges **19** which extend around the edges of the crossheads and are bolted thereto. The tension plates have windows **20** to allow slabs S to pass therethrough. The base frame carries rests **26** at each side of the center line for slidably supporting the tension plates.

We mount a first opposed pair of hydraulic rams **21** and **21***a* in crossheads **16** and **16***a* for forcing the slide housing **14** and **14***a* toward each other. Similarly we mount a second opposed pair of hydraulic rams **22** and **22***a* in the crossheads for forcing the other slide housings **15** and **15***a* toward each other. We interpose removable blocks **23** between the hydraulic rams and slide housings to transmit ram forces to the housings. Within the base frame **10** we mount four hydraulic pull-back cylinders **24**, only two of which are shown (FIGURES 1 and 2). We connect these cylinders with the respective slide housings **14**, **14***a*, **15** and **15***a* for separating the housings. The hydraulic rams and pull-back cylinders have suitable connections for admitting and discharging fluid under pressure to position the slide housings.

We fabricate the four slide housings of steel plates rigidly fastened together. At their lower ends the housings have keeper plates **25** to retain them in the respective slideways **12** and **13** (FIGURE 2). The slide housings extend upwardly from the base frame between the tension plates **17** and **17***a*. The slide housings all have relatively high centers of gravity, and the slide housings **15** and **15***a* have only narrow supporting bases on their slideways **13**. To furnish better stability for the slide housing **15**, we mount two tension slide assemblies (one upper and one lower) between housings **14** and **15**. As FIGURE 4 shows, each lower tension slide assembly includes a tension bar **28** attached to the slide housing **15** and extending through a slot **29** in the wall of the slide housing **14**. Two pairs of rollers **30** are journaled to the tension bar and ride on wear plates **31** fixed to the inner face of housing **14**. The attaching means for the tension bar includes a built-up rubber sandwich **32** which we compress after the parts are assembled to provide the desired pre-tension in the assembly. We also mount a series of mating tool steel bearing strips **33** and bronze wear strips **34** between the housings to provide sliding contact surfaces. The upper tension slide is similar (FIGURE 2). We also mount similar upper and lower assemblies (not shown) between the slide housing **14***a* and **15***a*.

The slide housing **14** contains two lower roll chocks **35** and **36** and two upper roll chocks **37** and **38** aligned with the respective lower chocks (FIGURE 2). Similarly the slide housing **15** contains aligned lower and upper roll chocks **39** and **40**. We journal a primary roll **41** in the two chocks **35** and **37**, an intermediate roll **42** in the two chocks **36** and **38**, and a finishing roll **43** in the two chocks **39** and **40**. The primary and intermediate rolls **41** and **42** are of the same diameter, but we insert shims **44** within the slide housing **14** behind chocks **36** and **38**, whereby the circumference of the intermediate roll projects further inwardly (FIGURE 3). The finishing roll **43** is of larger diameter and projects still farther inwardly. Each roll has a respective flange **45** at its lower end and tapers slightly from its upper end to its flange. During a rolling operation the taper drives the slab S downwardly against the flange to position the slab and prevent vertical movement in either direction.

The upper end of the primary roll **41** has an integral splined extension **46** to which we connect the splined sleeve of a flexible drive spindle **47**. The upper end of housing **14** carries a speed reducer **48**, the output shaft of which is mechanically coupled to the upper end of spindle **47**. A motor bracket **49** is carried on two upstanding slot-

ted pins **50** mounted on the housing of the speed reducer and is held in position by suitable locking wedges and tie bolts (not shown). Bracket **49** carries drive motor **51** removably coupled to the input side of the speed reducer for driving the primary roll **41**. The finishing roll **43** has a splined extension **52** and drive spindle **53**, and the slide housing **15** carries a speed reducer **54**, motor bracket **55** and motor **56** all arranged similarly to corresponding parts just described. The intermediate roll **42** is an idler. Each of the slide housings **14** and **15** carries a respective lubricant pump **57** and drive motor **58** therefor, which form part of a forced lubrication system for its speed reducer. We have not shown details of the speed reducers, motors or lubrication system since per se they can be of conventional construction. The housings of motors **51** and **56** carry blowers **59** and drive motors **60** therefor. The parts carried by the other housings **14***a* and **15***a* are of similar construction to those carried by housings **14** and **15**, although in some instances of opposite hand; hence we have not repeated the description.

As FIGURE 3 shows, we mount two air-water atomizing spray nozzles **61** adjacent the rear of each roll **41, 42** and **43**. We connect these nozzles to the plant water and compressed air supply lines through suitable piping and control and operating valves (not shown). We also mount roll wipers **62** behind the rolls to prevent the cooling spray from impinging on the slab and to wipe excess water from the rolls before they contact the slab.

The mill also has upper and lower slab guides between the opposed slide housings to restrain slabs S against unusual vertical movement. The lower slab guide includes a supporting table **65** fixed to the base frame **10**, pedestals **66** removably mounted on table **65**, and a pair of rails **67** mounted on the pedestals (FIGURES 1 and 4). The upper guide includes a pair of cross beams **68** and **69** supported on horizontal roll stands A and B at the entry and exit ends of our mill (FIGURES 5, 6 and 7). The beams carry respective upstanding slotted pins **70** on which we removably mount a tie member **71**. We insert wedges **72** in the slots in said pins to restrain the guide against upward movement. The tie member has two pairs of spaced upstanding lugs **73** of inverted U-shape, a pair of vertical passages **74** beneath the spaces between lugs, and a depending portion **75** which fits between the beams **68** and **69**. We insert a wedge **76** between one end of the depending portion **75** and beam **69**, but leave a gap **77** between the other end and beam **68** to allow for thermal expansion. We mount respective posts **78** in passages **74** for vertical adjustment. The mounting means includes a screw **79**, collars **80** and **81** fixed to the screw, and a nut **82** nonrotatably held between lugs **73** and threadedly receiving the screw. The posts are suitably apertured to accommodate the screw and nut. We attach a guide beam **83** to the lower ends of the posts and a pair of inverted rails **84** to the bottom of the beam. The bottom rails **67** lie slightly below the level of flanges **45** on the rolls, while the top rails **84** are adjustable vertically to accommodate slabs of different thickness.

Our edge-rolling mill is situated between two horizontal roll stands A and B which can be of conventional construction. We operate the hydraulic rams **21, 21***a*, **22** and **22***a* to position the primary, intermediate and finishing rolls **41, 42** and **43** in accordance with the slab width. The slab S enters from the roll stand A, and the three sets of edging rolls act on it in turn. Next the slab goes to the roll stand B. As the slab passes through our mill, the top and bottom guides assures that it remains properly positioned in the rolls. The horizontal roll stands A and B serve to tension the slab as it travels through our mill. During a rolling operation the tension plates **17** and **17***a* react the separating forces from the rams. The slidable engagement of the ram crossheads **16** and **16***a* with the base frame **10** and of the tension plates with the rests **26** enables the tension plates to expand under the separating force loads and permits the resulting movement of tension plates and ram crossheads. The keyed center connections **18** carry any differential loading between the rams resulting either from a ram failure or from slab misalignment.

Our mill is readily disassembled for repair or maintenance. As FIGURE 8 shows, the outside faces of the slide housings carry chain mechanisms **85** which we use to lift the blocks **23** from the spaces between the hydraulic rams and slide housings. We then operate the pull-back cylinders **24** to spread the slide housings to provide clearance between the speed reducers at the upper ends of the slide housings. Next we remove the lower slab guide **66, 67** from table **65**, and the tie member **71** of the upper slab guide from the cross beams **68** and **69**. We retract or collapse the spindles **47** and **53** from the splined extension **46** and **52** and thus free the rolls. We detach the chocks from the slide housings, and by use of suitable handling equipment, move each roll and its chocks into the space between housings. We then lift each roll and its chock from the top of the mill with a crane hook **86**. We can also remove the motor brackets **49** and **55** and motors **51** and **56** as units from the slide housings.

The electric and hydraulic circuits used to operate our mill are equipped with controls for driving the rolls at proper speeds and positioning the rolls at the proper location with respect to the slab. We have not shown or described these controls, since they are designed according to known principles and are not of our invention.

While we have shown and described only a single embodiment of our invention, it is apparent that modifications may arise. Therefore, we do not wish to be limited to the disclosure set forth but only by the scope of the appended claims.

We claim:

1. An edge-rolling mill for slabs comprising a base frame, a first opposed pair of slide housings supported on said base frame for transverse sliding movement, a second opposed pair of slide housings supported on said base frame adjacent said first pair for transverse sliding movement independently thereof, a pair of primary rolls and a pair of intermediate rolls journaled on vertical axes in said first pair of slide housings, a pair of finishing rolls journaled on vertical axes in said second pair of slide housings, drive means mounted on said slide housings and operatively connected with said primary and finishing rolls, said intermediate rolls being idlers, and hydraulic means mounted on said base frame operatively connected with said slide housings for positioning said rolls.

2. A rolling mill as defined in claim **1** further comprising upper and lower slab guides mounted between the slide housings on opposite sides to prevent unusual vertical movement of a slab.

3. A rolling mill as defined in claim **1** in which said hydraulic means includes ram crossheads slidably supported at opposite sides of said base frame, hydraulic rams mounted in said crossheads in alignment with the respective slide housings for pushing them toward each other, front and rear tension plates keyed to said base frame and connecting said crossheads to react the separating forces from said rams, and pull-back cylinders mounted within said base frame and connected with the respective slide housings for separating them, the slidable support of said crossheads permitting expansion of said tension plates under separating force loads.

4. A rolling mill as defined in claim **1** further comprising tension slide means mounted on one pair of slide housings and engaging the other pair of slide housings to stabilize the slide housings yet permit relative sliding movement therebetween.

5. A rolling mill as defined in claim **1** in which said drive means includes drive spindles connected with the rolls, speed reducers mounted on the respective slide housings and having output shafts connected with said spindles, motor brackets mounted on the slide housings, and motors mounted on said motor brackets and operatively connected with said speed reducer.

6. The combination, with a pair of spaced horizontal roll stands for reducing the thickness of a hot steel slab, of an edge-rolling mill situated between said stands for reducing the slab width, said mill comprising a plurality of rolls arranged in opposed pairs and journaled on vertical axes for engaging the edges of the slab at a plurality of points, means operatively connected with said rolls for positioning the rolls of each pair successively closer together, and drive means operatively connected with the rolls of certain of said pairs, said stands being arranged to tension a slab as it passes through said mill, whereby the total section of the slab is reduced in one closely coupled operation.

7. The combination, with a pair of spaced horizontal roll stands for reducing the thickness of a hot steel slab, of an edge-rolling mill situated between said stands for reducing the slab width, said mill comprising a pair of opposed primary rolls, a pair of opposed intermediate rolls, and a pair of opposed finishing rolls, means journaling each of said rolls on a respective vertical axis, means operatively connected with said rolls for positioning each pair successively closer together, and drive means operatively connected with the primary and finishing rolls, said stands being arranged to tension a slab as it passes through said mill, whereby the total section of the slab is reduced in one closely coupled operation.

8. The combination, with a pair of spaced horizontal roll stands for reducing the thickness of a hot steel slab, of an edge-rolling mill situated between said stands for reducing the slab width, said mill comprising a base frame, a first opposed pair of slide housings supported on said base frame for transverse sliding movement, a second opposed pair of slide housings supported on said base frame adjacent said first pair for transverse sliding movement independently thereof, a pair of primary rolls and a pair of intermediate rolls journaled on vertical axes in said first pair of slide housings, a pair of finishing rolls journaled on vertical axes in said second pair of slide housings, drive means mounted on said slide housings and operatively connected with said primary and finishing rolls, and hydraulic means mounted on said base frame and operatively connected with said slide housings for positioning said rolls with each pair successively closer together, said stands being arranged to tension a slab as it passes through said mill, whereby the total section of the slab is reduced in one closely coupled operation.

9. A combination as defined in claim 8 in which said intermediate rolls are idlers.

10. A combination as defined in claim 8 in which said mill further comprises upper and lower slab guides mounted between the slide housings on opposite sides to prevent unusual vertical movement of a slab, said lower guide being supported on said base frame, said upper guide being supported on said stands.

11. The combination, with a pair of spaced horizontal roll stands for reducing the thickness of a hot steel slab, of an edge-rolling mill situated between said stands for reducing the slab width, said mill comprising a base

frame, a first opposed pair of slide housings supported on said base frame for transverse sliding movement, a second opposed pair of slide housings supported on said base frame adjacent said first pair for transverse sliding movement independently thereof, a pair of primary rolls and a pair of intermediate rolls journaled on vertical axes in said first pair of slide housings, a pair of finishing rolls journaled on vertical axes in said second pair of slide housings, drive means on said slide housings operatively connected with said primary and finishing rolls, ram crossheads slidably mounted on said base at opposite sides of the mill, hydraulic means mounted in said crossheads and operatively connected with said slide housings for positioning said rolls with each pair successively closer together, and front and rear tension plates connected between said crossheads at opposite sides to react the separating forces from the hydraulic means as a slab passes between said rolls, said tension plates having windows to permit the slabs to pass, the slidable support of said crossheads permitting expansion of said tension plates under separating force loads, said stands being arranged to tension a slab as it passes through said mill, whereby the total section of the slab is reduced in one closely coupled operation.

12. A combination as defined in claim 11 in which said tension plates are keyed at their midportions to said base frame, and including rests mounted on said base frame slidably supporting said tension plates.

13. A rolling mill as defined in claim 1 further comprising front and rear tension plates connected to said hydraulic means, said front plate extending across said first pair of housings, said rear plate extending across said second pair of housings, said plates reacting the separating forces from the hydraulic means as a slab passes between said rolls and having windows permitting slabs to enter and leave the mill.

14. A combination as defined in claim 8 in which said mill further comprises front and rear tension plates connected to said hydraulic means, said front plate extending across said first pair of housings, said rear plate extending across said second pair of housings, said plates reacting the separating forces from the hydraulic means as a slab passes between said rolls and having windows permitting slabs to enter and leave the mill.

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