May 14, 1963 J. H. DILKS 3,089,287

SLAB GRINDER, HYDRAULIC COUNTERBALANCE AND LIFT CONTROL

Filed July 11, 1961 4 Sheets-Sheet 1

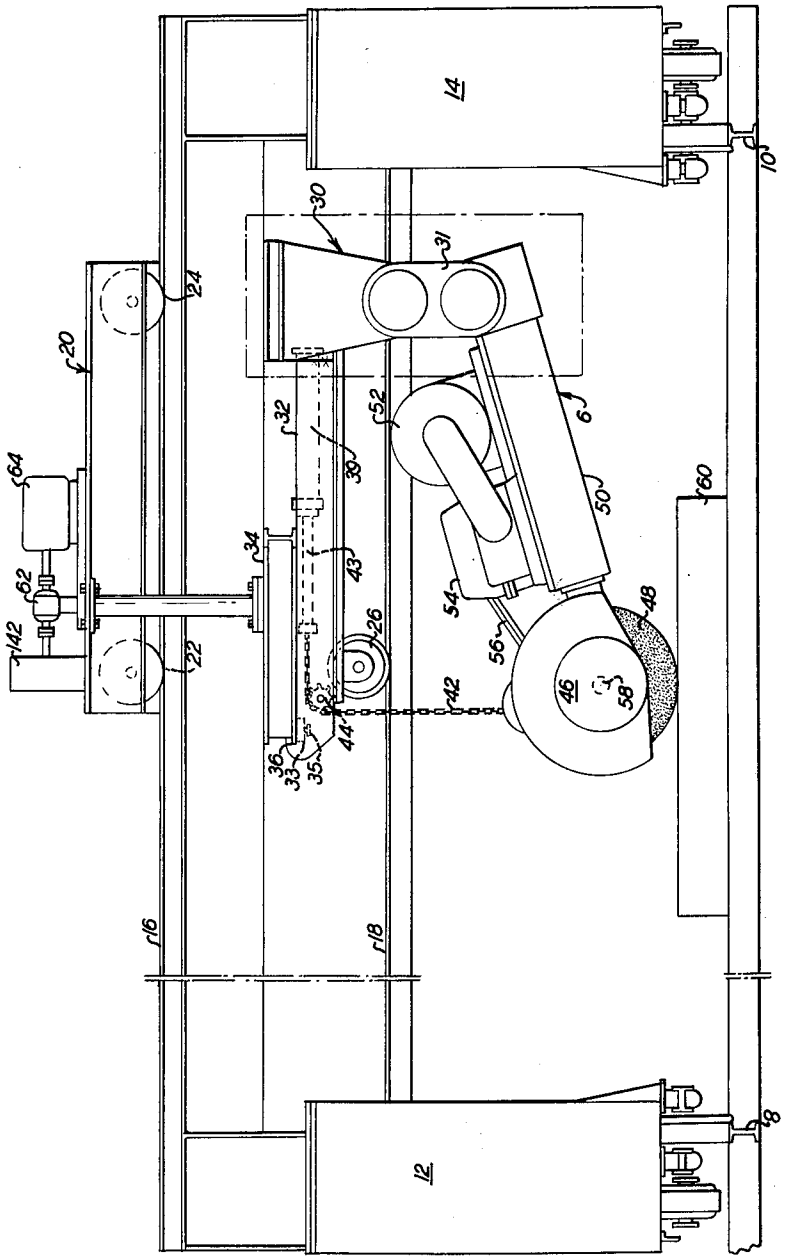


Fig. 1

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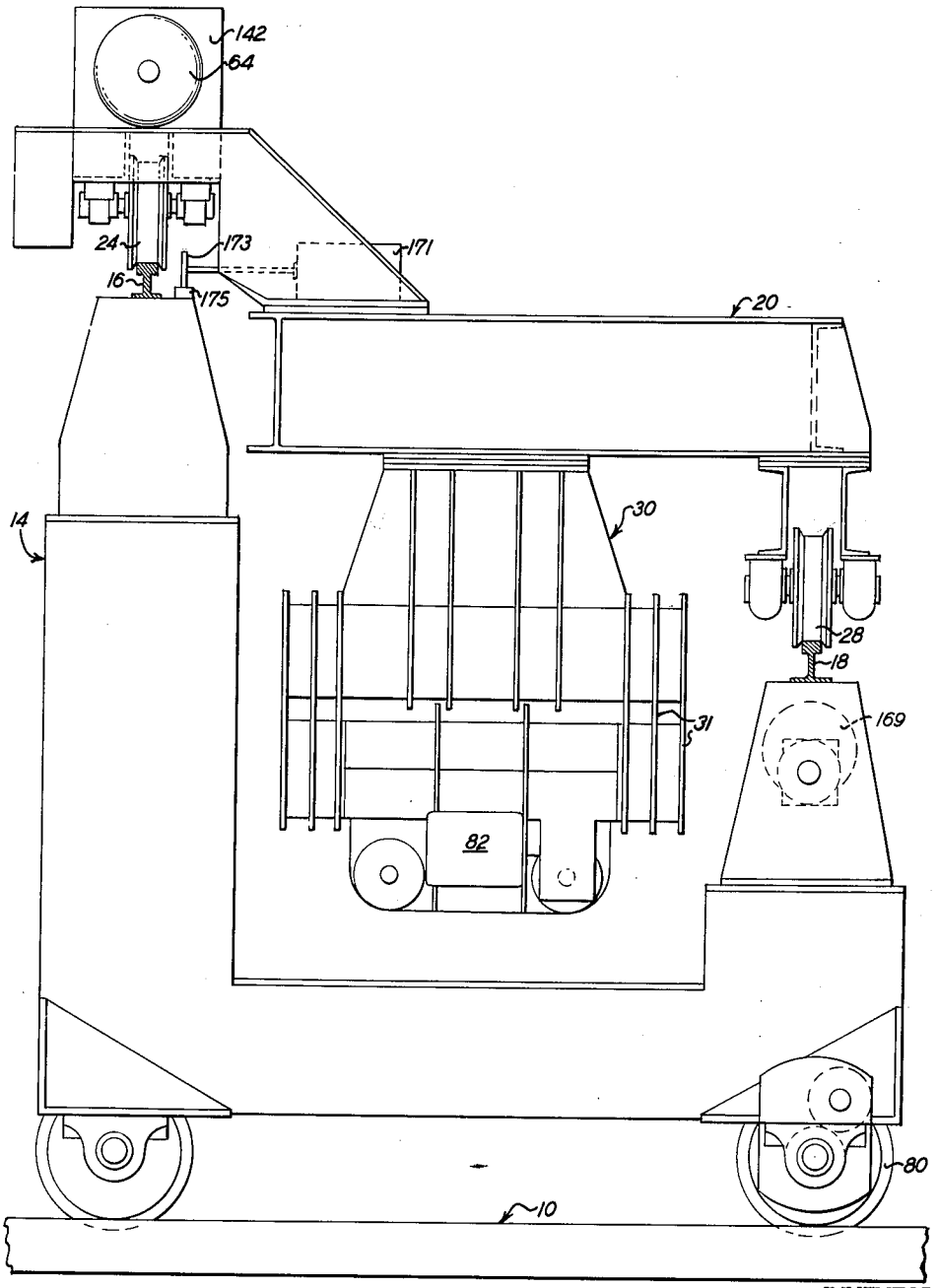


Fig. 2

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SLAB GRINDER, HYDRAULIC COUNTERBALANCE AND LIFT CONTROL

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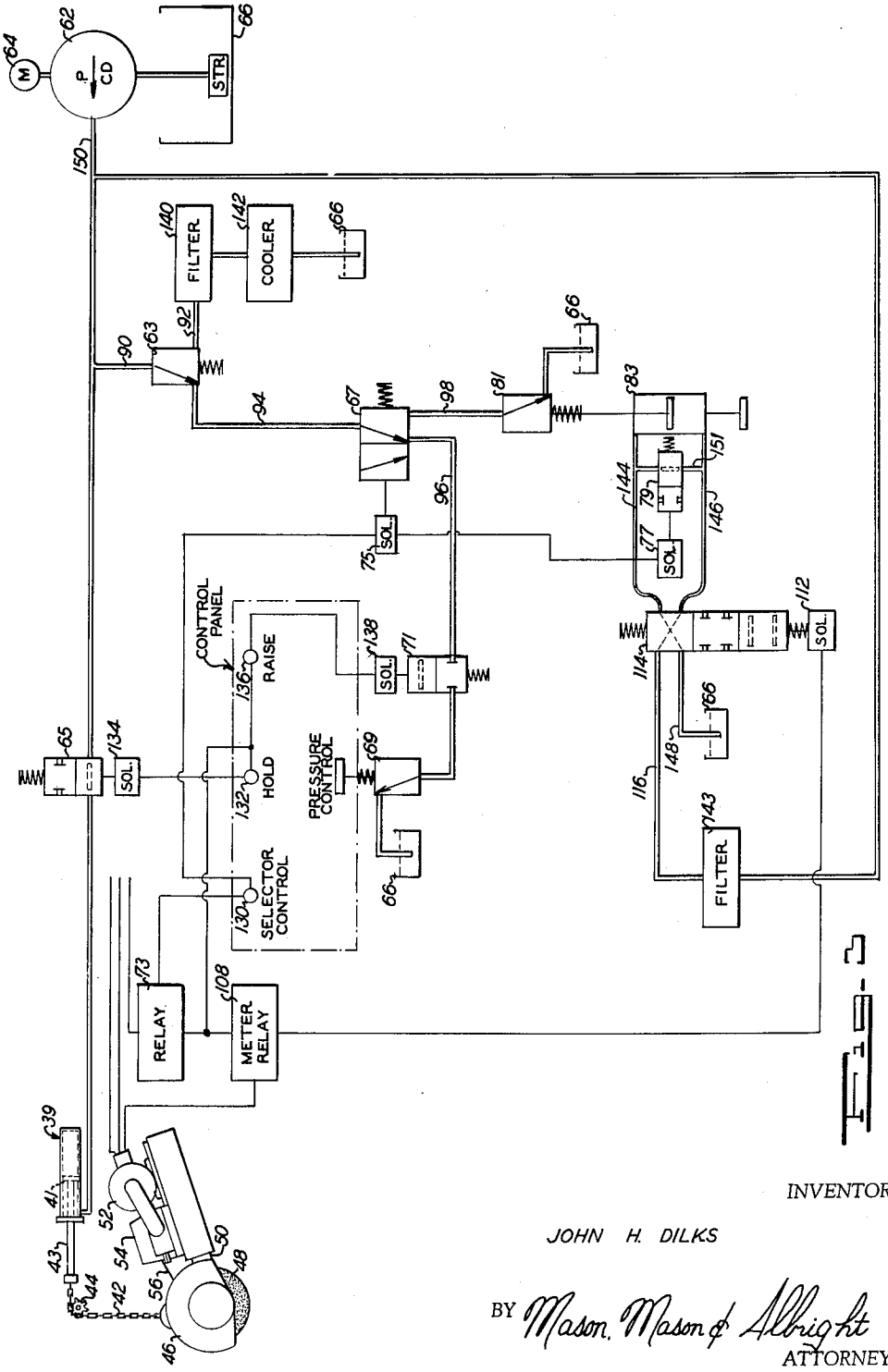


FIG. 5

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SLAB GRINDER, HYDRAULIC COUNTERBALANCE AND LIFT CONTROL

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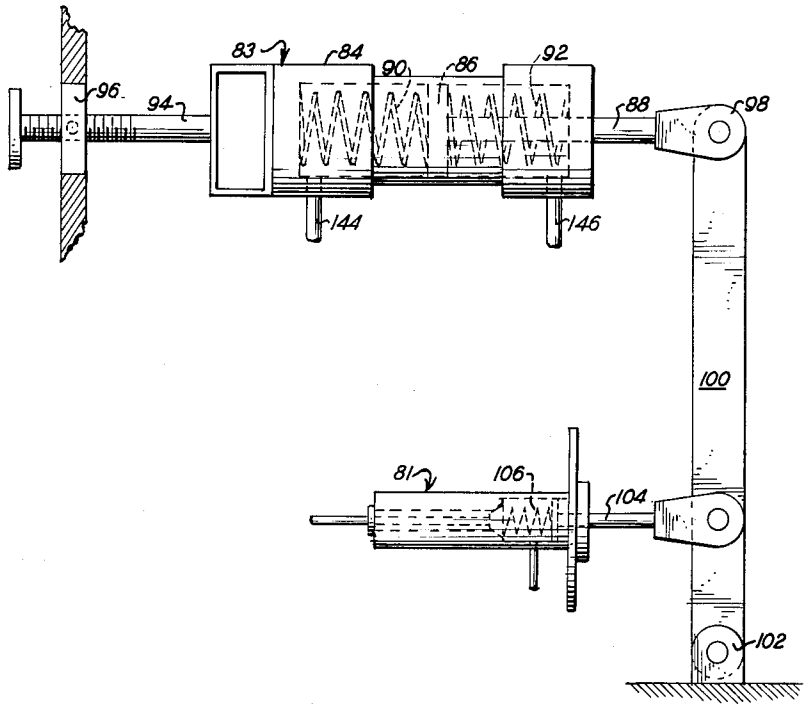


FIG. 4

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SLAB GRINDER, HYDRAULIC COUNTERBALANCE AND LIFT CONTROL

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5 Claims. (Cl. 51—35)

This invention relates to slab grinders and more particularly to such a grinder having a hydraulic counterbalance and the means for controlling same.

Slab grinders are utilized for the grinding of the surfaces of semi-finished steel slabs prior to subjecting them to rolling operations incident to the production of plate. Prior to this invention a similar slab grinder, as disclosed in my co-pending application Serial No. 55,072, filed September 9, 1960, now Patent No. 3,052,067, dated September 4, 1962, controlled the pressure of the grinder on the slab surface by providing a selectable constant pressure in the hydraulic counterbalance cylinder. The instant application is for an improvement on the device of the prior application whereby the power load on the grinding wheel motor may be maintained substantially constant, and constitutes a continuation-in-part thereof.

It is thus the object of this invention to provide a control system for a hydraulic counterbalance in a slab grinder for the convenient regulation of either the grinding wheel pressure or the power load of the grinding wheel motor.

The advantage of the invention is that it permits an integrated control system for various types of slabs. For example, slabs which have unduly sloping or irregular faces are not as adaptable to a constant grinding pressure as slabs with more nearly level faces and require continuous hand adjustment of the counterbalancing hydraulic pressure. For such slabs, a constant grinding motor wattage is preferable. Under the system of this invention, either the motor wattage or the grinding pressure can be maintained at a predetermined level. Moreover, the grinding wheel can be run off the edge of the slab without falling and can be lifted quickly as desired.

To these and other ends the invention resides in the improvements and combinations as will hereinafter be more fully described, the novel features being pointed out in the claims forming a part hereof, at the end of the specification.

In the drawings:

FIGURE 1 is a side elevational view of the slab grinder;

FIGURE 2 is a rear elevational view of the slab grinder;

FIGURE 3 is a diagrammatic view of the slab grinder's hydraulic and electrical control system; and

FIGURE 4 shows the controller cylinder and its linkage with the automatically-controlled pressure relief valve.

The slab grinder **6** is mounted so as to be movable fore and aft on a pair of spaced parallel rails **8** and **10**. The spaced trucks **12** and **14** which ride on the foregoing rails are transversely connected by a further pair of spaced rails **16** and **18** which provide the support for the carriage frame or overhead trolley **20** of the grinder.

The overhead trolley **20** consists of an overhead frame supported by four wheels **22**, **24**, **26**, and **28**, two engaging each transverse rail **16** and **18**. A grinding unit support **30** is rotatably secured to the underside and at one end of the trolley **20**. A beam **32** extends horizontally from the upper portion of support **30** to an arcuate I-beam **34** secured to the underside of the carriage frame opposite support **30**. The beam **32** embraces the lower portion of the I-beam **34** in a slot **36** so as to be slideably supported thereby. The I-beam **34** is curved to permit the beam **32** to slide along it in an arc so as to be supported thereby at all times. A lug **33** is rigidly secured within beam **32** adjacent to I-beam **34**. Lug **33** has a threaded hole to receive a bolt **35** which may be screwed against I-beam **34** to secure the relative position of I-beam **34** and beam **32** at any desired angle of operation.

Secured within beam **32** is a hydraulic motive means comprising a cylinder **39** with a piston **41** which is provided with a rod **43**, which reciprocates within cylinder **39**. Attached to rod **43** is a linkage member comprising a chain **42**, which rides over a sprocket pulley **44** secured to the beam **32**, and which is connected at its opposite end to guard **46** which supports the abrasive wheel **48**. An arm **50** is pivoted at one end to the lower portion of the support **30** through a connecting link **31** directly underneath the aforementioned beam **32**. Mounted on the arm **50** is an electric grinder motor comprising an induction motor **52** which utilizes pulleys and a belt to drive a speed controller **54** mounted adjacent thereto on arm **50**. The variable speed controller **54**, which may comprise a gear box, transmits rotary motion through belt **56** to the abrasive wheel **48**, the same being rotatably mounted on a transverse axle **58** secured within the guard **46**. The guard **46** is in turn mounted on the end of arm **50** opposite support **30** and link **31**.

The abrasive wheel **48** is raised and lowered from the slab **60** by movement of the piston rod **43** which is linked thereto through chain **42**. In practice, the weight of the abrasive wheel **48**, guard **46** and other structure which is borne by chain **42** is substantial. For example, the combined weight may approximate two tons. However, in this invention it is possible to adjust the actual downward force of abrasive wheel **48** on slab **60**, from the full combined weight of the grinding head structure to practically zero pounds. This is accomplished by varying the hydraulic pressure of the fluid within the cylinder **39** on the rod side of piston **41**.

At the start of grinding, grinding motor **52** is running with a "no load" current and a pumping unit **62** comprising a fixed volume fluid pump, such as a Racine Model Q pump, is pumping hydraulic fluid from a sump or reservoir **66** against a head which has been predetermined by setting a H. P. (high pressure) relief valve **63** at say 700 pounds per square inch. A locking valve **65** comprising a two-day solenoid valve is opened. Selector valve **67** comprising a four-way solenoid valve is ported for a grinder control valve **69** comprising a remote control pressure relief valve, acting as a pressure regulator, and the intervening lift actuator valve **71** comprising a two-way solenoid valve is closed. At the high pressure

thus maintained, the grinding head is held in a raised position.

To lower the head and start grinding, lift actuator valve 71 is opened and the hydraulic pressure against piston 41 is determined by the hand setting of grinder control valve 69. Since the weight of the grinding head exceeds the now reduced hydraulic force on piston 41, the head drifts down to meet the work. The amperage in motor 52 increases as the grinding commences and when it reaches a predetermined amount, a relay 73 is actuated to energize solenoid 75 of selector valve 67 and solenoid 77 of an equalizer valve 79 comprising a two-way solenoid valve. Solenoid 75 shifts the control of the hydraulic pressure from grinder control valve 69 to motor control valve 81 comprising an automatically controlled relief valve acting as a pressure regulator. Solenoid 77 closes equalizer valve 79 leaving the controller cylinder 83 in a neutral position.

FIGURE 4 shows the relationship of the controller cylinder 83 and motor control valve 81. The controller cylinder 83 comprises a cylinder 84 which contains a piston 86 with a rod 88 extending through one end of cylinder 84. Piston 86 and rod 88 are adapted to reciprocate in cylinder 84. However, centering springs 90 and 92 which are in compression act to center piston 86 in cylinder 84. A screw 94 is secured on one end to cylinder 84 and at the other to a boss 96 by a threaded connection. The rod 88 extending from the other end of cylinder 84 controls the pressure relief setting of valve 81. This may be accomplished by means such as pivotally connecting rod 88 at 98 to a lever 100 which is pivoted at its fulcrum to a boss 102. Bosses 96 and 102 are rigidly fixed relative to one another and are connected to trolley 20. Connected on lever 100 intermediate pivot 98 and its fulcrum is a rod 104 which acts on spring 106 to control the relief setting of motor control valve 81. Like bosses 96 and 102, motor control valve 81 is secured in a fixed position relative to trolley 20 and said bosses. It will be readily appreciated that the initial tension on relief valve spring 106 is determined by setting of screw 94.

The desired constant current for motor 52 is selected in advance—at, say for the purpose of example, 100 amperes. This is accomplished by a meter relay 108. Relay 108 energizes solenoid 112 when the current increases over 100 amperes to place electrohydraulic servo valve 114 in the position shown in FIGURE 3, and hydraulic fluid from line 116 acts on piston 86 to bring lever 100 closer and consequently raise the relief setting of valve 81 which in turn raises the hydraulic pressure against piston 41 in cylinder 39. This acts to raise the grinding wheel 48 slightly so that less power is required of motor 52. This, in turn, causes a drop to 100 amperes. With this, relay 108 will, through solenoid 112, bring valve 114 into a closed position thus locking the fluid in the controller cylinder 83 which causes a constant hydraulic pressure to be maintained in the system. Should the amperage to the motor fall below 100 amperes, relay 108 will, through solenoid 112, place valve 114 in a position opposite that shown in FIGURE 3. The hydraulic pressure is then applied to the opposite end of controller cylinder 83 to move lever 100 through the linkage piston 86 and rod 88, away from cylinder 83. As a consequence, the setting of relief valve 81 is lowered with a resultant lowering of the hydraulic pressure against piston 41 in cylinder 39. The grinding wheel pressure is slightly increased and more power is required of motor 52. Hence there is a corresponding amperage increase and when 100 amperes is reached relay 108 brings valve 114 to a neutral position. Piston 86 is locked in place by the trapped fluid. Valve 114 together with solenoid 112 may comprise any appropriate commercial electrohydraulic servo control valve.

In view of the foregoing, it will be seen that electrohydraulic valve 114 will attempt to maintain a constant current in motor 52 by feeding hydraulic fluid first to one side of cylinder 83 and then to the other. The position of piston 86 in cylinder 83 determines the setting of relief valve 81 which in turn raises and lowers the hydraulic pressure of the system.

In grinding at the end of the work, lock valve 65 is closed just before wheel 48 drops off the edge. This locks the hydraulic fluid in cylinder 39 so that wheel 48 is held at the correct height on return to work. Due to the motor current dropping to "no load" control temporarily returns to grinder control valve 69. Upon return of the grinder to the slab and opening of locking valve 65, the motor current increases and control immediately shifts back to motor control valve 81.

By opening selector switch 130 which de-energizes solenoid 75 and permits selector valve 67 to move to the position shown in FIGURE 3, control is retained at all times by grinder control valve 69 and the grinder wheel 48 thus maintains a constant pressure.

At the end of grinding, the head is raised by shifting to grinder control valve 69 by opening selector switch 130 and then closing the lift actuator valve 71. This returns control of the hydraulic pressure to H. P. relief valve 63. When the wheel 48 is raised, locking valve 65 may be closed to hold the grinding head in the top position.

A control to grinder control valve 69, the selector switch 130, the hold switch 132 which controls locking valve 65 through solenoid 134, and the raise switch 136 which controls the lift actuator valve 71 through solenoid 138 will normally be located together in an operator's cab attached to the grinder at a convenient vantage point—usually to trolley 20.

The hydraulic pressure is provided by a constant volume pump 62 which is mounted appropriately on the trolley 20 and driven by any suitable driving means such as an electrical motor 64. The pump 62 draws from a reservoir 66 which is also mounted on trolley 20 directly under pump 62. An outlet line 150 leads from the pump, through valve 65 and into cylinder 39 to act against piston 41. A branch 90 leads to H. P. relief valve 63 which relieves through a line 92 via filter 140 and cooler 142 back to sump 66. Relief valve 63 is interiorly bypassed into line 94 which leads to selector valve 67. From selector valve 67, one line 96, containing lift valve 71, leads to the grinder control valve 69 and from which fluid is relieved back to sump 66. The other line 98 from selector valve 67 leads directly to the motor control valve 81 from whence the hydraulic fluid is returned to sump 66. A line 116 containing a 5-micron filter 143 interconnects electrohydraulic servo valve 114 and line 150. Lines 144 and 146 connect the electrohydraulic valve 114 to the opposite side of controller cylinder 83. A discharge line 148 carries hydraulic fluid from the electrohydraulic servo valve 114 back to sump 66. Line 151 connects the opposite end of central cylinder 83 through intervening equalizer valve 79.

The slab grinder 6 is propelled on rails 8 and 10 by means of a motor 169 connected through belts and pulleys to wheel 80 in one of the end trucks. The trolley 20 is similarly propelled back and forth by a motor 171 which drives a sprocket 173 which in turn engages a chain rack 175 secured along rail 16. The grinder head structure may be oscillated by a motor 82 and a gear reducer located upon the rear of the arm near the support.

The above description and drawings disclose a single embodiment of the invention, and specific language has been employed in describing the several figures. It will, nevertheless, be understood that no limitations of the scope of the invention are thereby contemplated, and that various alterations and modifications may be made such as would occur to one skilled in the art to which the invention relates.

I claim:

1. In a slab grinder, an abrasive wheel, an electric motor to rotate said wheel, a hydraulic motive means comprising a cylinder, a piston in said cylinder, and a piston rod extending through an end of said cylinder from said piston, linkage means interconnecting said wheel and said piston rod, said wheel supportably depending from said linkage means, a pump, hydraulic fluid, said pump maintaining said fluid under pressure in said hydraulic motive means acting on said piston against the weight of said wheel, a pressure regulator for said fluid in said hydraulic motive means, a controller included in said pressure regulator to control the pressure of said fluid in said hydraulic motive means, electric actuation means associated with said electric motor and said controller, said electric actuation means being sensitive to the amperage of said motor and acting upon said controller causing the pressure of said fluid to be increased to reduce the downward force of said wheel on a slab and the amperage requirement of said electric motor when said amperage increases over a predetermined amount and to be decreased with the opposite effect when said amperage decreases under a predetermined amount whereby the amperage of said electric motor is maintained within predetermined limits, a second regulator for maintaining a predetermined amount of pressure of said fluid in said hydraulic motive means, a selector valve for switching the control of pressure of said fluid to said second regulator when said amperage drops to no load.

2. In a slab grinder, an abrasive wheel, an electric motor rotating said wheel, a hydraulic motive means comprising a cylinder, a piston in said cylinder and a piston rod extending through an end of said cylinder from said piston, linkage means interconnecting said wheel and said piston rod, said wheel supportably depending from said linkage means, a pump, hydraulic fluid, said pump maintaining said fluid under pressure in said hydraulic motive means acting on said piston against the weight of said wheel, a pressure regulator for said fluid in said hydraulic motive means, said pressure regulator including a spring urged relief valve and spring tension control means, a controller cylinder comprising a cylinder, a piston in said cylinder, yieldable centering means for said piston, and a piston rod extending through an end of said cylinder from said piston, leverage means operatively interconnecting the last-mentioned piston and the spring tension control means of said pressure regulator, conduit means interconnecting said pump and opposite ends of said controller cylinder to provide hydraulic fluid under pressure thereto, solenoid operated valve means in said conduit, said valve means selectively regulating the ingress and egress of hydraulic fluid to each end of said controller cylinder, electrical means responsive to the amperage in said electric motor, said electrical means actuating said solenoid operating valve means whereby when the amperage of said electric motor changes from a predetermined amount said valve means permits the ingress of fluid to one side of said controller cylinder and egress from the other side to modify the position of its piston and the spring tension control means operatively interconnected thereto to modify the pressure of the hydraulic fluid in said hydraulic motive means, said last-mentioned pressure being increased when the amperage of said electric motor increases and decreased when the amperage decreases, a second regulator for maintaining a predetermined amount of pressure of said fluid in said hydraulic motive means, a selector valve for switching the control of pressure of said fluid to said second regulator when said amperage drops to no load.

3. In a slab grinder, an abrasive wheel, an electric motor to rotate said wheel, a hydraulic motive means comprising a cylinder, a piston in said cylinder, and a piston rod extending through one end of said cylinder from said piston, linkage means interconnecting said

wheel and said piston rod, said wheel depending and being supportable from said linkage means, a pump, hydraulic fluid, conduit means, said pump interconnected with said hydraulic motive means by said conduit means and maintaining said fluid under pressure in said hydraulic motive means acting on said piston against the weight of said wheel, a valve for locking said fluid under pressure in said hydraulic motive means included in said conduit means, a pressure regulator interconnected in said conduit means between said valve and said pump, a controller included in said pressure regulator to control the pressure of said fluid in said hydraulic motive means, electric actuation means associated with said electric motor and said controller, said actuation means being sensitive to the amperage of said electric motor and acting upon said controller causing the pressure of said fluid to be increased to reduce the downward force of said wheel on a slab and the amperage of said electric motor when said amperage increases over a predetermined amount and to be decreased with the opposite effect when said amperage decreases under a predetermined amount whereby the amperage of said electric motor is maintained within predetermined limits, a second regulator for maintaining a predetermined amount of pressure of said fluid in said hydraulic motive means, a selector valve for switching the control of pressure of said fluid to said second regulator when said amperage drops to no load.

4. In a slab grinder, an abrasive wheel, an electric motor to rotate said wheel, a hydraulic motive means comprising a cylinder, a piston in said cylinder, and a piston rod extending through an end of said cylinder from said piston, linkage means interconnecting said wheel and said piston rod, said wheel supportably depending from said linkage means, a hydraulic fluid pump, hydraulic fluid, conduit means, said pump interconnected with said conduit means and maintaining said fluid under pressure in said hydraulic motive means acting on said piston against the weight of said wheel, a high pressure relief valve connected to said conduit means set to relieve at a pressure wherein said hydraulic motive means will lift said grinding wheel, a pressure regulator interconnected in said conduit means between said high pressure relief valve and said pump, a stop valve incorporated in said conduit means between said pressure regulator and said high pressure relief valve isolating all fluid egresses between said pump and said hydraulic motive means except through said high pressure relief valve, a controller included in said pressure regulator to control the pressure of said fluid in said hydraulic motive means, electric actuation means associated with said electric motor and said controller, said actuation means being sensitive to the amperage of said electric motor and acting upon said controller causing the pressure of said fluid in said hydraulic motive means to be increased to reduce the downward force of said wheel on a slab and the amperage of said electric motor when said amperage increases over a predetermined amount and to be decreased with the opposite effect when said amperage decreases under a predetermined amount whereby the amperage of said electric motor is maintained within predetermined limits, a second regulator for maintaining a predetermined amount of pressure of said fluid in said hydraulic motive means, a selector valve for switching the control of pressure of said fluid to said second regulator when said amperage drops to no load.

5. In a slab grinder, an abrasive wheel, an electric motor to rotate said wheel, a hydraulic motive means comprising a cylinder, a piston in said cylinder, and a piston rod extending through an end of said cylinder from said piston, linkage means depending from said piston rod, said wheel supportably connected to said linkage means, a hydraulic fluid pump, hydraulic fluid, conduit means, said pump interconnected with said conduit means and maintaining said fluid under pressure in said hydraulic

motive means acting on said piston against the weight of said wheel, a selector valve incorporated in said conduit means, a first pressure regulator controlled manually, a second pressure regulator controlled by the amperage of said electric motor, each of said pressure regulators connected with said selector valve whereby the pressure in said hydraulic motor is selectively regulated by said first pressure regulator and said second pressure regulator, said first pressure regulator being operatively connected to said selector valve when said amperage drops to no load.

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