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Streckert

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[54] **MATERIAL HANDLING MACHINE**

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[52] **U.S. Cl.** ..... **214/6 FS;** 214/1 BT

[51] **Int. Cl.** **B65g 57/04**

[58] **Field of Search** ..... 214/6 G, 6 FS, 1 BT, 1 BB, 214/6 P

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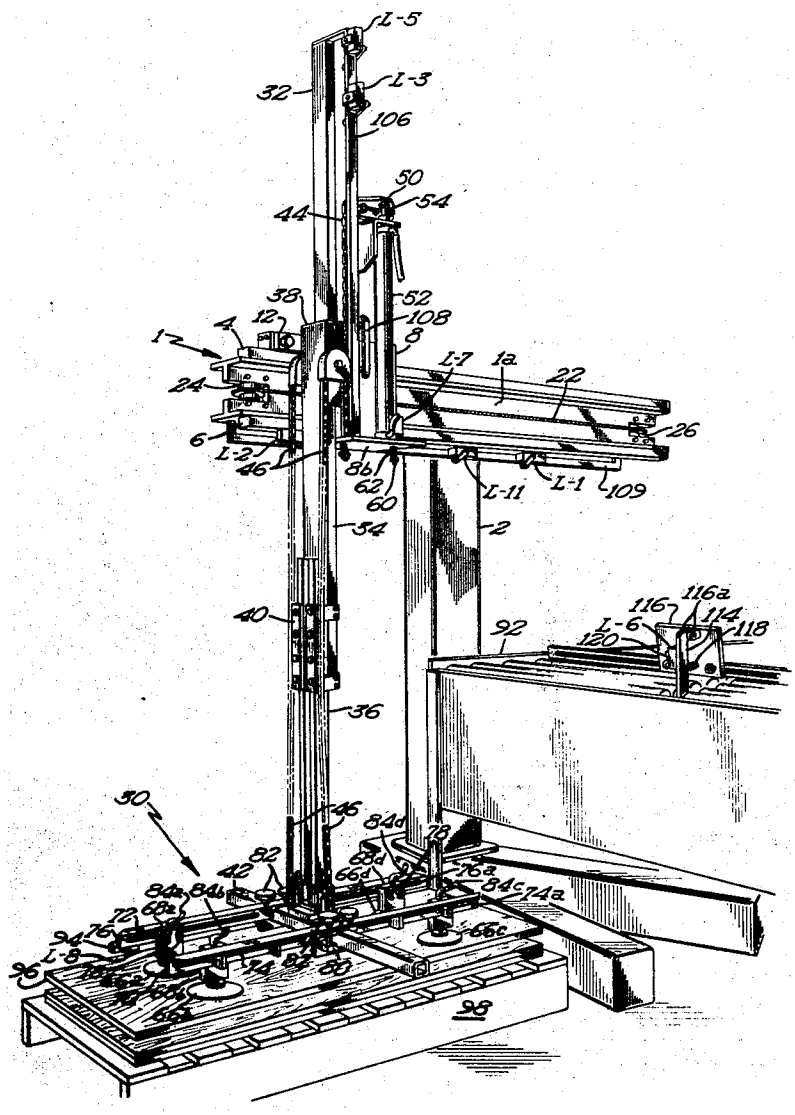
Primary Examiner—Frank E. Werner

Attorney, Agent, or Firm—Williamson, Bains & Moore

[57] **ABSTRACT**

A material handling machine having a laterally shiftable, elevated carriage on which a vertically shiftable lift head is mounted is provided with controls which operate the machine to automatically perform the multiple functions of picking up material from a receiving bed in response to the accumulation of a predetermined length of material thereon, lifting the material to only the minimum height required to clear a stack of material on which the material is being stacked in response to the height of the stack, carrying the picked up material laterally to a predetermined point above the receiving stack and lowering the material onto the stack or other receiving surface in response to the actuation of a control switch by the carriage when it reaches the predetermined point. The downward stroke of the lift head is automatically stopped in response to the forming of slack or free play in the lift head drive mechanism when the lift head strikes a contact surface on its downward stroke.

16 Claims, 9 Drawing Figures



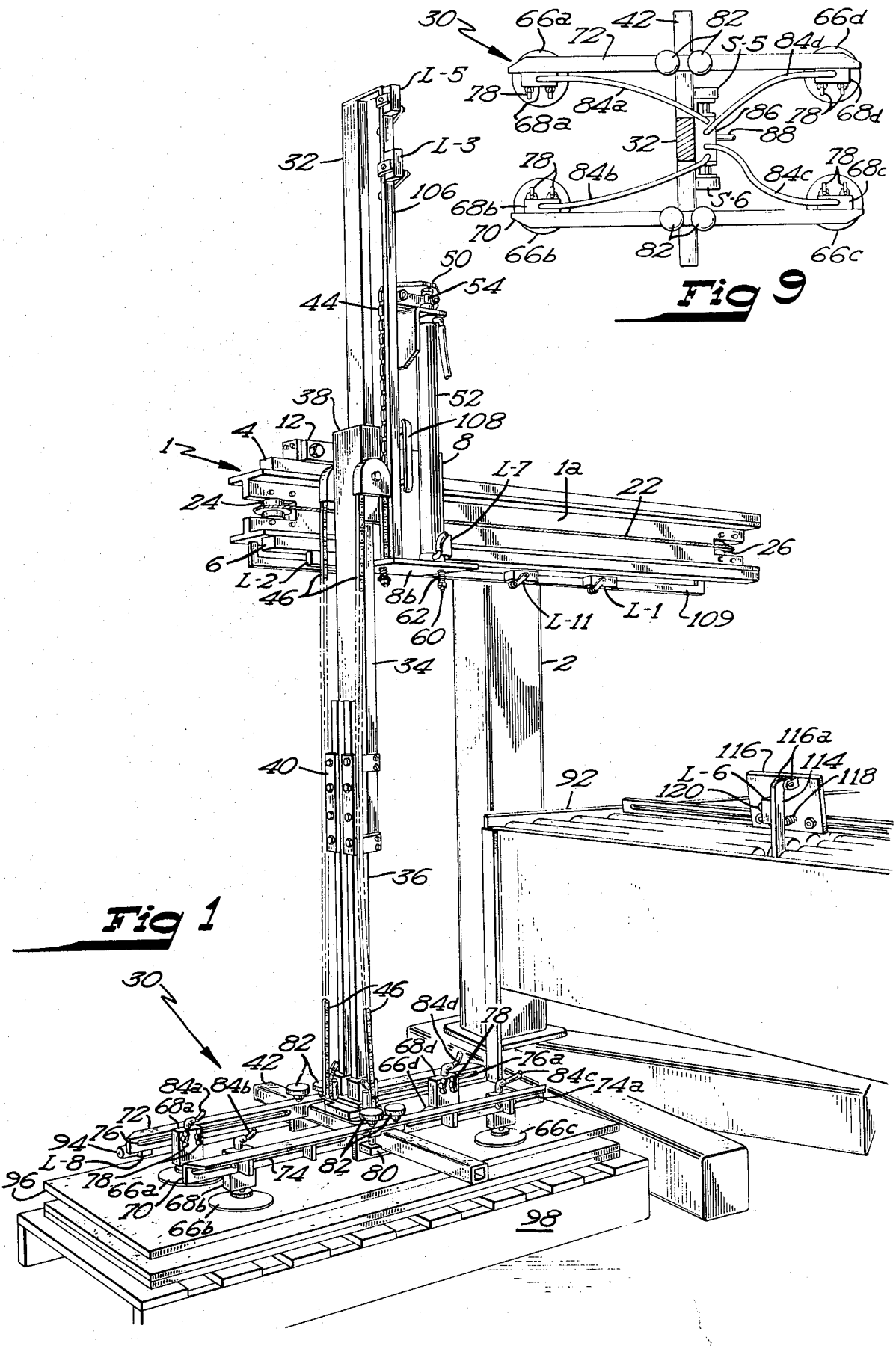

30
66a
72
42
82
66d
5-5
84d
L-5
78
84a
68a
86
78
68d
88
32
L-3
78
84b
84c
78
68c
106
68b
5-6
70
66b
82
66c
50
54
44
38
52
108
12
4
8
1-2
L-7
1a
22
24
26
6
L-2
46
86
62
60
L-11
L-1
109
34
2
40
116a
116
114
118
L-6
120
92
36
30
46
84d
78
82
42
68d
66d
76a
84a
84b
84c
74a
72
68a
66c
94
76
L-8
96
78
66a
74
82
80
70
68b
66b
98

Fig 9

Fig 1

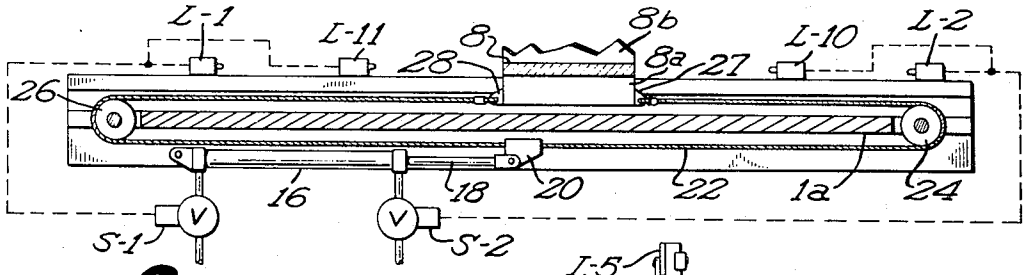

L-1
L-11
8
8b
8a
28
27
L-10
L-2
26
16
18
20
22
1a
24
V
V
S-1
S-2

Fig 2

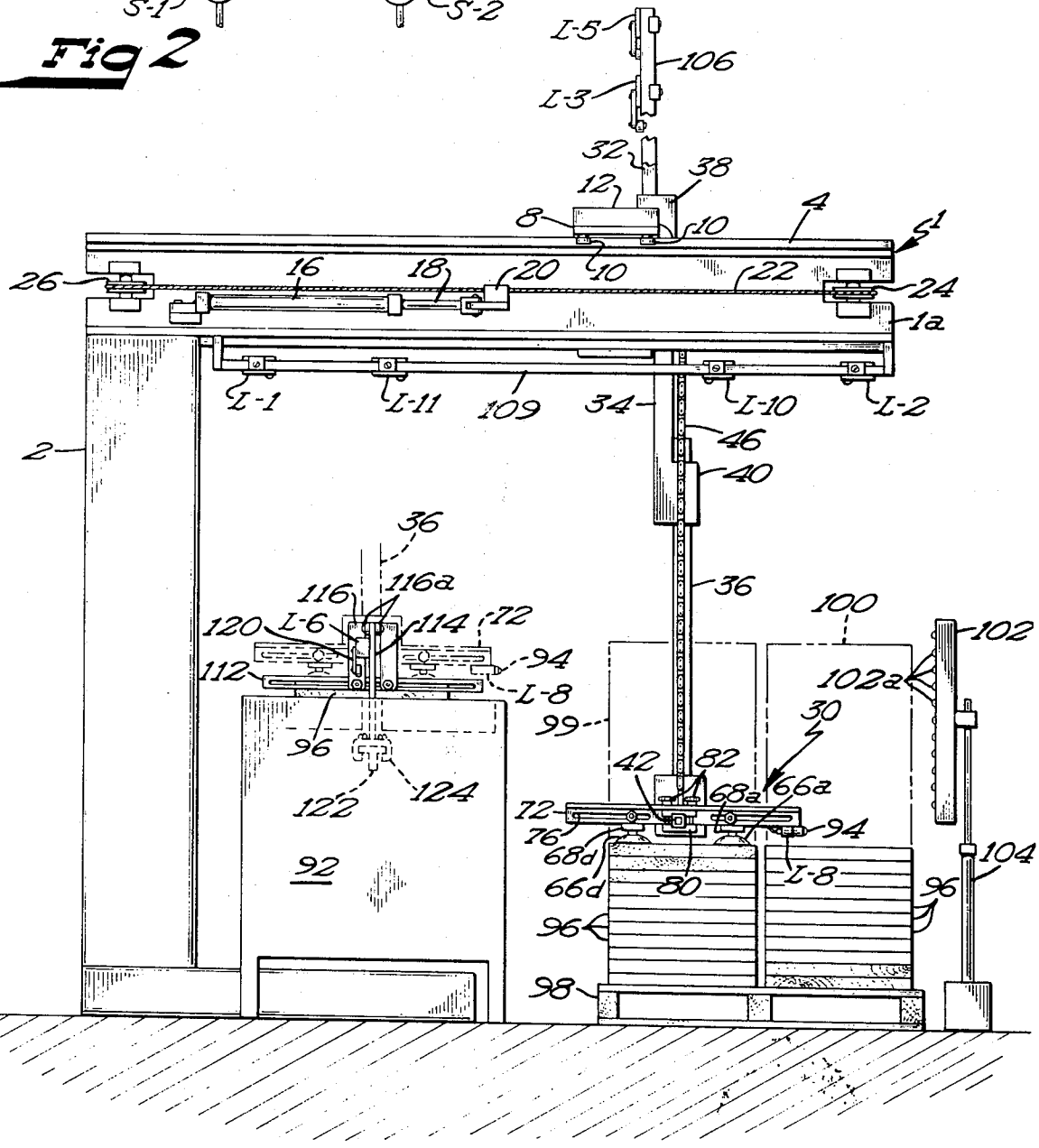

L-5
106
L-3
32
38
12
8
10
4
S1
26
16
18
20
10
22
24
1a
L-1
L-11
109
34
L-10
L-2
46
40
2
36
116
116a
120
L-6
114
72
94
112
L-8
96
122
124
92
36
100
102
102a
99
30
42
82
68a
66a
72
76
94
68d
66d
80
L-8
104
96
96
98

Fig 3

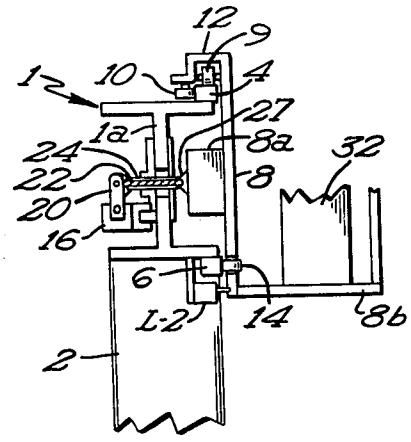


Fig 5

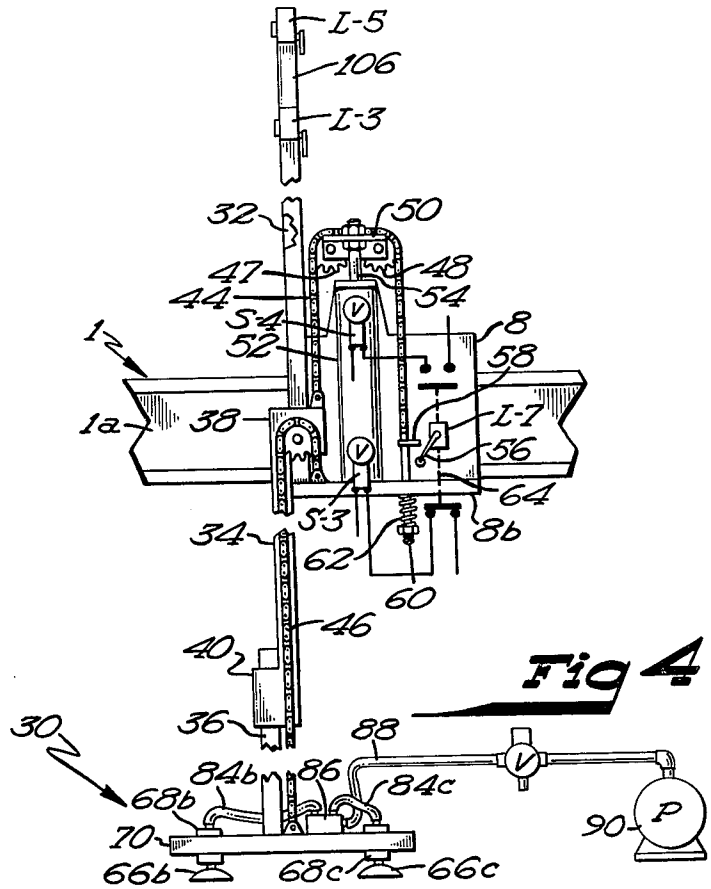


Fig 4

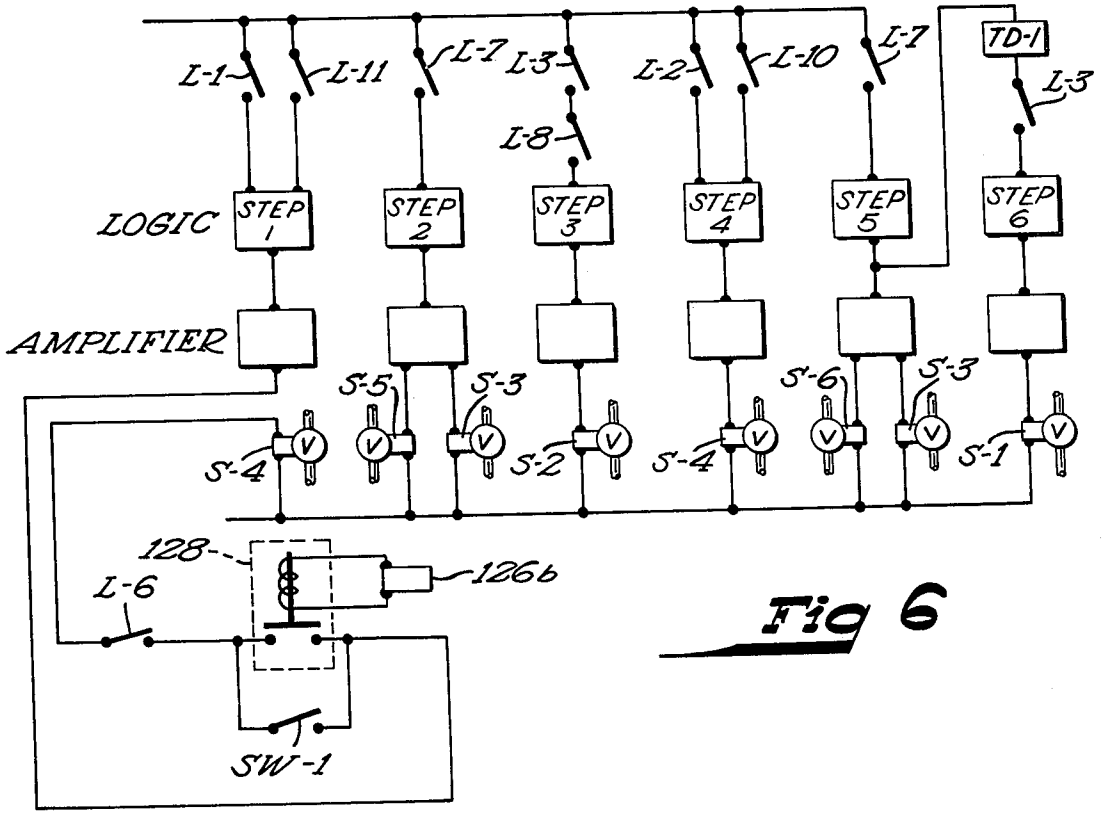


Fig 6

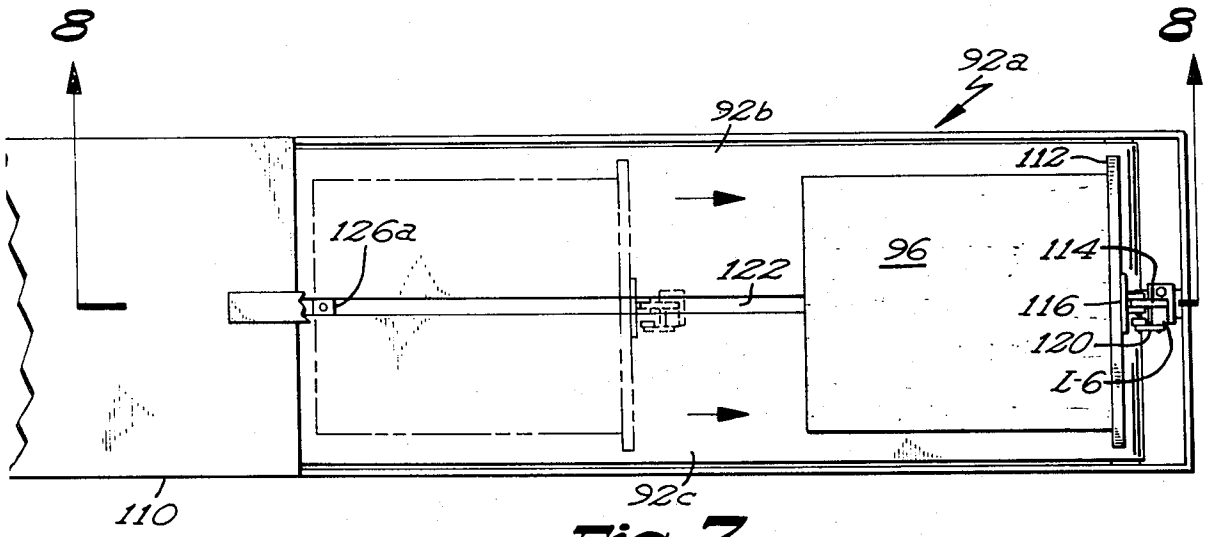

8
8
92a
92b
112
126a
122
96
114
116
120
I-6
110
92c

Fig 7

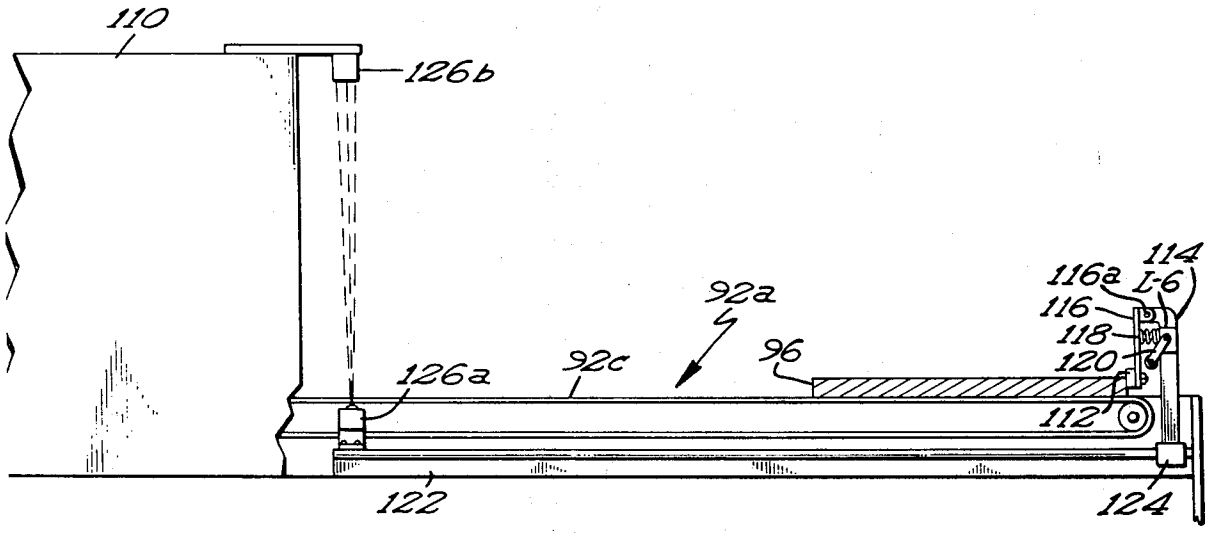

110
126b
92a
114
116a
I-6
116
118
120
126a
92c
96
112
122
124

Fig 8

MATERIAL HANDLING MACHINE

BRIEF SUMMARY OF THE INVENTION

The material handling machine of this invention has been designed and built with a view towards automatically handling material, particularly sheet material, with maximum efficiency in the course of the multiple steps of picking up pieces of material from a supply station, moving laterally with the material and depositing it at a predetermined location at a receiving or stacking station.

These basic objectives have been realized by utilizing a horizontally shiftable carriage on an elevated guide track, mounting a vertically shiftable lift head with material pickup means on the carriage and providing controls to automatically operate the carriage and lift head to carry out the aforesaid material handling steps.

A particularly advantageous control feature of the machine resides in the use of a lift head lowering control which is responsive to the generation of slack in the lift head drive mechanism when the lift head strikes a contact surface, to thereby stop the lift head downward stroke immediately to avoid damage to the machine and to the material being handled. In the preferred form of the machine, a chain drive operated by a power cylinder is utilized to raise and lower the lift head, and when the lift head strikes a contact surface, a spring acting on one end of the drive chain shifts the slackened chain to carry a trip device attached to the chain into contact with the actuator of a control switch which then operates to stop the downward movement of the lift head.

As a further beneficial feature of my material handling machine, I provide it with a multiple pickup control function in accordance with which the lift head of the machine is lowered to pick up material from a receiving bed only after a predetermined length of material has accumulated on the bed. This is preferably accomplished by locating a control device, such as a photoelectric cell, adjacent the receiving bed in front of a material stop a predetermined distance substantially equal to the total length of material desired to be picked up. The control operates in response to the presence of material on the receiving bed at the control location for a predetermined period of time to actuate the lift head on its downward stroke to pick up the material accumulated on the receiving bed between the stop and the control device.

A height control function is incorporated in the machine and utilizes a sensing device responsive to the height of a stack of material on which the machine is placing pieces of material to terminate the upward movement of the lift head with a piece of material at a supply station when the lift head reaches a level above the height of the material stack. This feature eliminates unnecessary elevation of the lift head and initiates the lateral movement of the lift head to the stacking station at a point above the material being stacked when the lift head has risen high enough to clear the stack on which it must deposit the piece of material it has picked up at the supply station. These and other objects and benefits of my invention will become readily apparent as the following description is read in conjunction with the accompanying drawings wherein like reference numerals have been used to designate like elements throughout the several views.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the material handling machine of this invention;

FIG. 2 is a horizontal section view taken along lines 2—2 of FIG. 3 and showing the laterally shiftable carriage of the machine;

FIG. 3 is a side elevation view of the machine of FIG. 1 performing a material stacking function;

FIG. 4 is a fragmentary, side elevation view of the machine of FIG. 1 taken from the opposite side of the machine from that shown in FIG. 3 and illustrating the mechanism for raising and lowering the lift head;

FIG. 5 is a fragmentary, left end elevation view of the machine shown in FIG. 1;

FIG. 6 is a control diagram illustrating the various control steps of the machine;

FIG. 7 is a top, plan view of a receiving bed with controls mounted thereon for controlling the total length of accumulated material which the machine picks up at one time;

FIG. 8 is a front, elevation view of the receiving bed and controls shown in FIG. 7; and

FIG. 9 is a top, plan view of the lift head for the material handling machine.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, I have shown in FIG. 1 a preferred embodiment of my material handling machine having an elevated support boom 1 in the form of an I-beam mounted on an upright pedestal 2. Guide tracks 4 and 6 extending longitudinally along the top and bottom faces of I-beam 1 serve to shiftably support and guide a carriage 8 which is laterally shiftable back and forth on boom 1. Carriage 8 may be shiftably supported on guide tracks 4 and 6 in various ways for sliding or rolling support thereon. For illustrative purposes, as most clearly appears in FIG. 5, I have utilized rollers for this purpose. An upper set of rollers 9 and 10 attach to a horizontal extension 12 of carriage 8 engage the top and rear, side faces of upper guide track 4; and a bottom roller 14 engages the front face of lower guide track 6.

It will be appreciated that various types of reversible motor means may be utilized to move carriage 8 back and forth on the guide tracks 4 and 6 of boom 1. I have found that a pneumatic cylinder is particularly suitable for this purpose, such a cylinder and its associated piston being designated by reference numerals 16 and 18 in FIGS. 2 and 3. The mounting and drive arrangement of cylinder 16 with respect to carriage 8 may best be understood by reference to FIGS. 1 through 3 and 5. Pneumatic cylinder 16 is mounted on the vertical web 1*a* of I-beam 1 as shown in FIG. 5, and a bracket 20 attached to piston 18 is secured to an elongated cable 22 guided around sheaves 24 and 26 rotatably supported on vertical axes mounted within the slotted ends of beam web 1*a* in the manner shown in FIG. 1. The ends of cable 22 are secured to a rearward extension 8*a* of carriage 8 by means of brackets 27 and 28 attached to the opposite sides thereof. The flow of pressurized air to the opposite ends of pneumatic cylinder 16 to reciprocate piston 18 in opposite directions is controlled by a pair of control devices in the form of solenoid valves S-1 and S-2.

A lift head generally indicated by reference numeral **30** is mounted on carriage **8** for lateral shifting movement therewith by vertically reciprocal carrier means. I have found it particularly advantageous to utilize a carrier means as shown comprised of a plurality of extensible and retractible lift beams **32, 34** and **36** which slidably support each other, and which are driven by a chain drive arrangement hereinafter described to provide a mechanical lift advantage. The lift apparatus may best be understood by reference to FIGS. **1** and **4.** Upper lift beam **32** is fixed at its bottom end to horizontal plate **8***b* of carriage **8** and slidably supports beam **34** by means of a slide head **38** on the upper end of lift beam **34** which embraces lift beam **32.** A similar slide head **40** is mounted on the bottom end of lift beam **34** and slidably supports and guides bottom lift beam **36.** At its lower end, lift beam **36** is secured to cross beam **42** of lift head **30.** For the purpose of raising and lowering lift beams **34** and **36,** I utilize bidirectional drive means in the form of a pair of drive chains **44** and **46.** Chain **44** is fixed at one end to a spring biased rod **48** extending through base plate **8***b* of carriage **8.** The opposite end of chain **44** is attached to slide head **38,** with chain **44** being guided around a pair of sprockets **47** and **48** mounted on a bracket **50.** Chain **46** is guided around a sprocket **52** attached to slide head **38** and is affixed at one end to base plate **8***b* of carriage **8.** At its opposite end, chain **46** is attached to lift head **30.** As may be noted with respect to the showing of chain **46** in FIG. **1,** both chains **44** and **46** may be double chains guided around a pair of sprockets. As a source of power for driving chains **44** and **46,** I utilize a reversible, double-acting pneumatic cylinder **52** having a reciprocating piston **54** attached at its upper end to mounting bracket **50** on which sprockets **47** and **48** are mounted. The flow of pressurized air to opposite ends of cylinder **52** to reciprocate piston **54** upwardly and downwardly is controlled by a pair of solenoid valves S-3 and S-4.

For the purpose of precisely controlling the downward stroke of lift head **30** so that it will stop immediately upon contacting a surface of any kind, I utilize a control switch designated L-7 having a trip arm **56** disposed in proximity to one end of chain **44.** The end of chain **44** near switch L-7 carries a trip bar **58** for actuating arm **56** of switch L-7. That same end of chain **44** is attached to a rod **60** which extends through base plate **8***b* of carriage **8** and is normally biased in a downward direction by a coil spring **62** on its lower end. It will be apparent that the load of lift beam **34** and lift head **30** normally acting downwardly on one end of chain **44** will keep chain **44** in tension, with the result that spring **62** will be compressed in a normally loaded condition by the upward force of segment **44***a* of chain **44** acting through rod **60.** This will cause trip bar **58** to be held at a normal, elevated position out of contact with arm **56** of switch L-7. There is enough "free play" or slack between drive chains **44, 46** and the lift beams **34** and **36** to which they are attached that when lift head **30** engages a contact surface on its downward stroke to thereby remove the tension stress normally exerted on chains **44** and **46** by the weight of the lift head and the lift beams, chain **44** will be freely movable through a limited distance by the unloading action of spring **62.** Spring **62** bears against the bottom base of carriage base plate **8***b*, and as it unloads downwardly, it will take up any slight slack generated in chain **44,** and thereby urge chain segment **44***a* downwardly. As chain **44***a* is shifted downwardly, trip bar **48** carried thereon will engage and trip actuating arm **56** of control switch L-7. When this happens, operating rod **58** of switch L-7 will be shifted downwardly to the position shown in FIG. **4** wherein it opens the contacts leading to solenoid valve S-4 and thereby shuts off the supply of pressurized air to the upper end of cylinder **52** to stop the downward stroke of piston **54.** This will of course immediately terminate the downward movement of chains **44** and **46,** and thus immediately stop the downward stroke of lift head **30** upon contact with a surface of any kind. When switch L-7 is actuated in the aforesaid manner, it simultaneously closes the contacts completing a circuit to solenoid valve S-3 to ready lift cylinder **52** for the upward stroke of piston **54** and the elevation of lift head **30.**

It will be appreciated from the foregoing description of the lift apparatus, that the use of at least one drive chain **44** or **46** in combination with power cylinder **52** provides a mechanical advantage with respect to the vertical movement imparted to lift head **30** by a particular displacement of piston **54** of cylinder **52.** With chain **44** guided around sprockets **47, 48** attached to piston **54,** the segment **44***b* of chain **44** attached to slide head **38** will be displaced vertically twice the distance through which piston **54** moves in a downward or upward stroke. Thus, lift beam **32** will move twice as far as piston **54;** and with a second chain **46** utilized in the manner shown and connected to lift head **30,** bottom lift beam **36** attached to lift head **30** will shift vertically four times the distance that piston **54** does on any particular upward or downward stroke. Thus, this particular lifting apparatus does not need an undue amount of space above support boom **1** to support lift head **30** in its position of maximum elevation, and thus does not require an unduly high ceiling for its use. Those skilled in the art will also recognize that other types of drive means other than the multiple chain drive shown may be utilized in combination with a biasing spring to actuate control switch L-7 in response to the generation of slack in the drive means when lift head **30** strikes a contact surface. For example, there is enough slack or free play between gear teeth that this same control principle could be utilized with a rack and pinion type of lift arrangement for lift head **30.**

With reference to FIGS. **1** and **4,** it may be seen that material pickup means are provided on lift head **30** in the form of a plurality of suction cups **66***a*, **66***b*, **66***c*, and **66***d*. These cups are attached to mounting blocks **68***a*, **68***b*, **68***c* and **68***d* for adjustable mounting on a pair of slide bars **70** and **72.** Bars **70** and **72** are provided with longitudinal slots **74, 74***a* and **76, 76***a* to accommodate the sliding movement of suction cup blocks **68***a* – **68***d* thereon. To this end, fasteners extending through mounting blocks **68***a* – **68***d* and through the slots in bars **70** and **72** are releasably secured thereto by wing nuts **78.** Slide bars **70** and **72** are also slidably mounted on cross beam **42** of lift head **30** by means of slide brackets **80** and fasteners **82.** By loosening fasteners **82,** bars **70** and **72** may be slidably adjusted transversely of lift head **30** on beam **42** to move suction cups **66***a* – **66***d* in and out transversely of lift head **30.** Thus, the combination of slidably adjustable mounting blocks **68***a* – **68***b* and slide bars **70** and **72** permits suction cups **66***a* – **66***d* to be adjusted longitudinally and transversely of lift head **30** to permit picking up varying numbers of pieces of different sizes. Although four suction cups have been

shown in the drawings, any number of suction cups could obviously be mounted on slide bar **70** and **72.** Also, I contemplate that different types of pickup means, such as magnetic pickup devices, could be satisfactorily used in place of the suction cups.

As may be noted with respect to both FIGS. **1** and **4,** suction cups are connected through flexible lines **84***a*, **84***b*, **84***c* and **84***d* with a four-way valve **86** connected in a main vacuum line **88.** Vacuum line **88** is connected to a vacuum source, such as the vacuum pump shown at **90** in FIG. **4.** Four-way valve **86** is controlled by a pair of oppositely acting solenoids S-5 and S-6 which operate to open and close this valve to supply and cut off the vacuum to suction cups **66***a* – 66*d.*

In FIG. **1** I have shown a conveyor **92** onto which pieces of material, such as sheets of plywood or panels of any kind are received from a processing machine, and which serves as a supply station at which lift head **30** picks up pieces of material and conveys them to a stacking station or other location for further processing. A photoelectric cell **94** is mounted on one end of slide bar **72** of lift head **30** in the manner shown in FIGS. **1** and **3** to accomplish a height control function with respect to the elevation of lift head **30,** as may best be understood by reference to FIG. **3.** In FIG. **3,** I have illustrated the material handling machine in the process of performing a stacking operation wherein lift head **30** is picking up pieces of plywood from conveyor **92** and depositing them at a stacking station where the wood panels **96** are stacked to a desired height on a pallet **98.** The wood panels may obviously be stacked in any number of piles or stacks **99** and **100** comprising a stacking station. In such a material stacking operation, the lift heads of stacking machines have been traditionaly controlled and operated to raise to a predetermined height after picking up a piece of material at a supply station before moving transversely to a stacking station, regardless of the height of the stack of material which must be cleared by the lift head. This necessarily involves a great deal of wasted motion of the lift head and lost time when the stack on which a piece of material is to be placed is lower than the predetermined height to which the lift head is always raised. This inefficient type of material handling in a stacking operation is eliminated by the use of photoelectric cell **94** in combination with a light source **102** comprised of a plurality of beam projecting lights **102***a*. Light source **102** is adjustably mounted on a standard **104** on the opposite side of stacks **99** and **100** from conveyor **92.** Beam lights **102***a* are positioned to send light signals along horizontal paths which intersect the vertical direction of extent of material stacks **99** and **100** accumulating at the stacking station. Photoelectric cell **94** functions as a signal sensing device and is mounted on slide beam **72** of lift head **30** so as to be directed towards light source **102** to receive light signals emitted by beam lights **102***a*. Photoelectric cell **94** operates to close the contacts across a switch designated L-**8.** Control switch L-**8** is connected in the control circuit shown in FIG. **6** in such a way as to stop the upward movement of lift head **30** and to initiate the lateral movement of carriage **8** from a position over conveyer **92** towards the right, as viewed in FIG. **3,** to a position over one of the stacks **99** or **100** when its contacts are closed. The control circuit shown in FIG. **6** includes a logic circuit comprised of a number of steps corresponding to operating functions of the machine and is explained completely hereinafter with respect to a complete operating cycle of the machine. It is sufficient to note at this point that the logic circuits shown in FIG. **6** are set up so that as each step is activated by a control switch, the preceding step is deactivated and the next succeeding step is energized for actuation. It will be seen that control switch L-**8** is connected in series with solenoid valve S-**2** in the circuit of step **3.** Thus, when the contacts of switch L-**8** are closed in response to the sensing of a light signal from one of the beam lights **102***a* by photoelectric cell **94,** solenoid S-**3** which controls the upward movement of power piston **54** as shown in FIG. **4,** is de-energized and closed to terminate the upward movement of lift head **30** and solenoid valve S-**2** is energized and opened. As may be noted by reference to FIGS. **2** and **3,** solenoid valve S-**2** permits the flow of pressurized fluid to the right end of pneumatic cylinder **16** so as to move piston **18** to the left, and thereby pull cable **22** in such a direction as to move carriage **8** to the right, for a stacking right operation.

It will be apparent that with one of the stacks **99** or **100** at a relatively high level as indicated by the phantom lies in FIG. **3,** the stack of material will block the transmission of a light signal to photoelectric cell **94** when it is at the level with lift head **30** shown in phantom lines just starting to move upwardly with a piece of material from conveyor **96.** Thus, photoelectric cell **94** will not receive a light signal from one of the beam lights **102***a* until it reaches a level above the height of stacks **99** and **100.** When lift head **30** and photoelectric cell **94** reach such a height, control switch L-**8** will be actuated in response to the reception of a light signal by photoelectric cell **94,** and will function to close solenoid valve S-**3** and to open solenoid valve S-**2** to stop the raising of lift head **30,** and to initiate the lateral movement of carriage **8** by pneumatic cylinder **16** in a direction towards the right to convey the piece of wood panel **96** picked up from conveyor **92** to a position over one of the stacks **99** or **100.** If the stacks **99** and **100** are at a level below lift head **30** when it picks up a piece of material from the top of conveyor **92,** then photoelectric cell **94** will immediately receive a light signal and actuate switch L-**8** so that lift head **30** will rise only a minimum clearance distance above the top of conveyor **92** and then start moving laterally towards stacks **99** and **100** immediately.

In order to insure that lift head **30** will always rise a minimum clearance distance above the top of conveyor **92,** or other supply source, I utilize a limit switch L-**3** in series with switch L-**8** in the circuit of step **3** shown in FIG. **6.** Limit switch L-**3** is mounted on an upright bar **106** clearly shown in FIG. **1,** as well as in FIG. **3** at a predetermined elevation to permit the lifting of head **30** to a minimum clearance height above the top of conveyor **92.** Limit switch L-**3** is actuated by trip bar **108** carried on lift beam **34** when beam **34,** and lift head **30** carried thereby reach the predetermined, minimum clearance height. Thus, it will be seen that both limit switch L-**3** and control switch L-**8** under the control of photoelectric cell **94** must be actuated before the lift head elevating function stops, and carriage **8** is shifted laterally to the right.

It should be noted that other types of signal sensing devices, such as an ultrasonic control device may be utilized in place of photoelectric cell **94** to sense the height of material stacks **99** and **100** and carry out the aforesaid lift height control function.

In FIGS. 1 and 3 there is shown an elongated bar **109** suspended under elevated support boom **1** which is utilized to support a plurality of limit switches L-**1**, L-**11**, L-**10** and L-**2** at the positions shown thereon. These limit switches are utilized in pairs, i.e., L-**1**, L-**11** and L-**10**, L-**2** to stop the lateral movement of carriage **8** at precise, predetermined positions to permit the alternate stacking or picking up of wood panels at or from multiple stacks or supply sources. For example, limit switches L-**10** and L-**2** are utilized to alternately stop the lateral movement of carriage **8** on a stacking right operation above stacks **99** and **100**. Each of these limit switches have actuating arms positioned to be triped by movement of carriage **8** into contact therewith, the actuating arms for two of the switches L-**1** and L-**11** being clearly shown in FIG. **1**. As is indicated in the control diagram of FIG. **6**, limit switches L-**2** and L-**10** are connected in parallel with each other, both in series with solenoid valve S-**4** in step **4** of the logic and control circuit. The logic circuits are arranged so that only one of the switches L-**2** or L-**10** is in the control circuit to solenoid S-**4** at one time. When one of these limit switches is actuated by carriage **8**, it stops the carriage and simultaneously actuates a circuit switching the other limit switch L-**10** into the control circuit for the next stacking operation. Thus, as carriage **8** first moves to the right as viewed in FIG. **3** after picking up a piece of wood paneling **96** from conveyor **92**, only switch L-**2** is in the control circuit and carriage **8** moves all of the way to the right until it actuates switch L-**2**. Switch L-**2** simultaneously opens the circuit through solenoid valve S-**2** and closes the circuit through solenoid valve S-**4**. This has the effect of stopping the movement of carriage **8** towards the right, by shutting off the flow of pressurized fluid to the right end of power cylinder **16**, and of permitting pressurized fluid to flow into the upper end of lift head cylinder **52** through solenoid valve S-**4** to initiate the downward movement of lift head **30** over stack **100**. The next time that carriage **8** moves to the right after picking up another piece of plywood or wood paneling **96** from conveyor **92**, it is stopped by limit switch L-**10** over stack **99**, switch L-**10** now being in the circuit, and switch L-**2** being out of the control circuit. Switch L-**10** performs the same functions as described above with respect to switch L-**2** and opening solenoid valve S-**2** in closing solenoid valve S-**4** to stop the movement of carriage **8**, and to initiate the downward movement of lift head **30** to deposit the piece of plywood on top of stack **99**. Obviously, any number of stacks may be utilized in combination with the corresponding required number of limit switches to alternately stack pieces of material in different stacking locations adjacent to each other.

It will also be appreciated by those skilled in the art, that switches L-**1** and L-**11** can be used in the same manner as described with respect to switches L-**10** and L-**2** to alternately actuate solenoid valve S-**1** to stop the movement of carriage **8** in a direction towards the left as viewed in FIG. **3** to permit picking up or depositing pieces of plywood or other sheet material from or on opposite sides of conveyor **92**. Also, stacks or material handling stations **99** and **100** could serve as alternate sources of supply of pieces of material being fed onto a conveyor, such as conveyor **92** to supply material to a processing machine. With such an operation, limit switches L-**2** and L-**10** would function in the same manner as described above to permit lift head **30** to alternately pick up pieces of material from stacks **99** and **100**.

In FIGS. 7 and 8 I have illustrated the manner in which additional controls may be utilized in conjunction with my material handling machine to actuate the downward stroke of lift head **30** to pick up a predetermined length of material accumulated on a receiving bed in the form of one article, or a plurality of articles. Reference numeral **110** designates a processing machine from which articles, such as sheets of plywood, are deposited on a receiving bed in the form of a conveyor **92***a*. Such a conveyor would be located with respect to pedestal **2** and the material handling machine in essentially the same manner as is conveyor **92** shown in FIG. **1**. Conveyor **92***a* is illustrated as a belt conveyor comprised of a pair of belts **92***b* and **92***c*. Positioned at one end of conveyor **92***a* at a predetermined location thereon is a stop means in the form of a stop bar **112** pivotally mounted on an upright support arm **114** by a pivot bracket plate **116**. Pivot bracket **116** pivots about point **116***a* at its point of connection to the upper end of support arm **114**. An additional control switch in the form of a limit switch L-**6** is mounted on support arm **114** with its actuating arm **120** positioned to be tripped by the rearward displacement of stop bar **112** about pivot point **116***a*. A spring **118** acting between support arm **114** and bracket plate **116** normally biases plate **116** and stop bar **112** forwardly so that plate **116** will be out of engagement with actuating arm **120** of limit switch L-**6**. In order that stop bar **112** may be adjustably positioned with respect to receiving bed **92***a* for the accumulation of a predetermined length of material, support arm **114** is slidably mounted on a guide rail **122** by a slide bracket **124**, as shown in FIG. **3** as well as in FIGS. **7** and **8**. A control device which may take various forms, and which is shown for illustrative purposes as a photoelectric cell controller comprised of a light source **126***a* and a light sensitive, receiving cell **126***b* is positioned at a predetermined location adjacent to receiving bed **92***a*. The photoelectric cell controller **126***a* – 126*b* is located with respect to bed **92***a* so that it will be a predetermined distance forwardly of stop bar **112** in the direction from which material is received from processing machine **110** such that the distance between stop bar **112** and the photoelectric controller will be substantially equal to a predetermined total length of material to be accumulated on conveyor **92***a* to be picked up at one time by lift head **30**. The light source **126***a* for the photoelectric cell is positioned under conveyor **92***a* between conveyor belts **92***b* and **92***c* so that if a sheet of material or other article stops over it, the transmission of the light beam to receiving cell **126***b* will be blocked. This will have the effect of closing contacts within receiving cell **126***b*, which is set to have its contacts closed when the light source to it is interrupted. Photoelectrc cell **126***b* is connected in the control circuit shown in FIG. **6** in step **1** of the logic circuit, in series with solenoid control valve S-**4** which controls the downward stroke of cylinder piston **54** and of lift head **30**. As is illustrated in FIG. **6**, a time delay relay **128** is connected in the control circuit in conjunction with the contacts of photoelectric cell **126***b* so as to be energized when the contacts of photoelectric cell **126***b* are closed. Time delay relay **128** is set to permit short lengths of material to move past the location of the photoelectric controller, over light source **126***a* without closing its contacts and completing the circuit

through solenoid control valve S-4. Thus, a plurality of short pieces of sheet material can pass onto conveyor 92*a* without actuating the down stroke of lift head 30. When a single piece of predetermined length, or a plurality of pieces of material equal to the total distance along receiving bed 92*a* between stop bar 112 and controller 126*a* – 126*b* have accumulated on the receiving bed, the transmission of light from source 126*a* to cell 126*b* will be permanently blocked. Thus, the time delay period for which time delay relay 128 is set will be exceeded and it will close its contacts to complete a circuit through solenoid valve S-4. As may be noted with respect to FIG. 4, solenoid controller S-4 directs the flow of pressurized fluid to the upper end of power cylinder 52 to move piston 54 downwardly and to lower lift head 30. Lift head 30 will be lowered by the drive chain arrangement described above until it contacts the material accumulated on conveyor 92*a*, and will pick up this material and carry it to a stacking station or other processing station as desired. The longitudinal adjustment of support arm 114 on guide rail 122 permits stop bar 112 to be longitudinally adjusted on the receiving bed towards and away from controller 126*a* – 126*b* to permit adjusting the distance therebetween for the particular length of material desired to be accumulated from processing machine 110, or from any other source.

Limit switch L-6 shown in FIGS. 1, 7 and 8 is connected in series with the photoelectric cell controller 126*a* – 126*b* in the manner shown in the control circuit diagram of FIG. 6. A manual switch designated SW-1 is connected in parallel with the photoelectric cell controller as shown in FIG. 6, and in series with limit switch L-6. By closing switch SW-1, the photoelectric cell controller can be bypassed and the machine will operate without the multiple pickup control function. It will be appreciated that with limit switch L-6 connected in the control circuit in such a manner, it must be actuated by the rearward displacement of stop bar 112 when a piece of material contacts bar 112 before the circuit to lift head control solenoid S-4 can be closed. When switch SW-1 is closed, the photoelectric cell controller 126*a* – 126*b* will be bypassed, and the tripping of limit switch L-6 when a piece of material is received on conveyor 92*a* will actuate solenoid valve S-4 and cause lift head 30 to move downwardly to pick up the piece of material.

A complete operating cycle of the material handling machine involving the several functions and control operations of the machine set forth above will now be described. For illustrative purposes, a so-called stack right cycle will be described, wherein the machine is picking up material from the conveyor 92 shown in FIG. 3 and moving to the right and stacking the pieces of material at the stacking station comprised of stacks 99 and 100. As is indicated in FIG. 6, there are six basic steps in the cycle, each step containing a logic section and an amplifier section. The logic section is turned on by a limit switch and the amplifier section is turned on by the logic section. The cycle shown starts with step 1. When the start switch for the machine (not shown) is turned on, step 1 is activated. The cycle starts with carriage 8 positioned at an elevated level over conveyor 92 at the left end of boom 1 as viewed in FIG. 3. Solenoid 4 will not be actuated to move piston 54 downwardly, and to lower lift head 30 until limit switch L-6 is actuated to indicate that a piece of material has been received on conveyor 92 and is in position to be picked up. If manual switch SW-1 is open, and the multiple pickup function controlled by the photoelectric controller 126*a* – 126*b* is operational, then this controller must also be actuated, and the contacts of time delay relay 128 closed in response to the accumulation of a predetermined length of material on the conveyor 92 before solenoid valve S-4 is energized. When this happens, piston 54 of the power cylinder 52 is moved downwardly, and the drive arrangement utilizing drive chains and the lift beams 34 and 36 lowers lift head 30 to pick up a piece of material from conveyor 92. When the suction cups 66*a* – 66*b* of lift head 30 contact the piece of material, limit switch L-7 is actuated in the manner described above to de-energize solenoid valve S-4 and terminate the downward movement of the lift head 30. The closing of switch L-7 also activates or turns on step 2 and completes a circuit through solenoid valves S-3 and S-5. Solenoid valve S-5 shifts four-way control valve 86, shown most clearly in FIG. 9, to its open position to connect the vacuum pump 90 with each of the suction cups 66*a* – 66*d*. In this manner, the piece of wood paneling or other sheet material is picked up by lift head 30, and the simultaneous actuation of solenoid valve S-3 shifts piston 54 upwardly to raise lift head 30. Lift head 30 will move upwardly until trip shoe 108 actuates limit switch L-3 indicating that the lift head has reached the minimum clearance height above the conveyor 92; and, if photoelectric cell 94 senses that the lift head 30 is above the height of the stacking piles 99 and 100, limit switch L-8 will be closed and the circuit through step 3 and solenoid control valve S-2 will be completed. Step 2 will simultaneously be deactivated. The actuation of solenoid valve S-2 will cause carriage 8 to be shifted to the right by power cylinder 16, and when one of the limit switches L-10 or L-2 is actuated, step 3 will be turned off and the circuit through step 4 will be completed. Carriage 8 will thus be stopped at a position over one of the stacks 99 or 100 and the actuation of solenoid valve S-4 in step 4 will cause piston 54 and lift head 30 to move downwardly to deposit the piece of material on top of one of the stacks. When the piece of wood paneling 96 contacts the stack, limit switch L-7 will again be actuated to stop the downward movement of lift head 30. This will turn off step 4 and complete the circuit through step 5 to actuate solenoid valves S-6 and S-3. Solenoid valve S-6 shifts four-way control valve 86 to its closed position to shut off the vacuum to the suction cups 66*a* – 66*b* and solenoid valve S-3 supplies pressurized fluid to the bottom of lift cylinder 52 to raise piston 54 and the lift head 30. At the same time, a time delay relay designated TD-1 shown in FIG. 6 is energized so that if the lift head is already above the conveyor 92 and limit switch L-3 is actuated lift head 30 will raise another slight distance upwardly before going into step 6 and moving laterally to the left. The closing of limit switch L-3 and the energizing of time delay relay TD-1 completes the circuit through step 6, and energizes solenoid controller S-1. As may be noted with reference to FIG. 2, solenoid controller S-1 directs the flow of pressurized fluid into power cylinder 16 at one end thereof so as to shift carriage 8 to the left as viewed in FIGS. 2 and 3. Carriage 8 will move to the left until it contacts one of the limit switches L-1 or L-11 which will operate to turn off step 6 and to energize or turn on step 1. At this time, a complete cycle will have been

completed and carriage **8** will be in position above conveyor **92** ready to pick up another piece of material, if there are one or more pieces of material on conveyor **92** serving to actuate limit switch L-**6** and/or controller **126***a* – 126*b* to initiate another cycle.

Limit switch L-**5** shown at the top of lift beam **30** in FIG. **1** is vertically positioned on bar **106** to be actuated by trip shoe **108** to shut off the machine when a pile of material such as that shown at stacks **99** and **100** has reached a predetermined, maximum height. An additional limit switch could be utilized with its actuating arm under a stack of material being picked up, so that when the last piece of material is removed from the stack, this limit switch will operate to shut off the machine after that piece is conveyed to its processing station.

I anticipate that various changes can be made in the structure and operating mechanism and controls of the material handling machine described herein without departing from the spirit and scope of my invention as defined by the following claims.

I claim:

1. A material handling machine comprising:

a lift head having material pickup means thereon;

a carrier means attached to said lift head, said carrier means being vertically shiftable upwardly and downwardly to raise and lower said lift head;

bidirectional drive means in driving association with said carrier means, there being sufficient free play between said drive means and said carrier means that when said lift head engages a contact surface on its downward stroke and thereby removes stress normally exerted on said drive means by said carrier means, said drive means will be freely movable through a limited distance, said drive means being operable in a first direction to raise said carrier means and said lift head and in the opposite direction to lower said carrier means and said lift head;

spring means engaging said drive means and maintained in a normally loaded condition by the stress normally exerted on said drive means by said carrier means;

a control switch operable in one position to stop the movement of said drive means in said opposite direction to limit the downward movement of said carrier means and lift head; and

a trip device for said control switch carried on said drive means, the unloading action of said spring when said pickup means engage a contact surface on the downward stroke of said lift head serving to move said drive means through said limited distance to thereby carry said trip device into a predetermined position wherein it actuates said switch to said one position wherein it stops the movement of said drive means in said opposite direction and terminates the downward movement of said carrier means and lift head.

2. A material handling machine as defined in claim **1** wherein:

said bidirectional drive means comprises at least one chain guided around a sprocket with one fixed end secured in biasing, coacting relation with said spring means and having its opposite end attached to said carrier means, whereby the load of said carrier means and said lift head on said one end of said chain normally maintains said chain in tension against the biasing pressure of said spring means, and the tension on said chain is thus removed when said pickup means engages a contact surface on the downward stroke of said lift head, thereby producing slack in said chain and permitting said spring to move said fixed end of said chain and said trip device therewith through said limited distance to actuate said control switch.

3. A material handling machine as defined in claim **2** wherein:

a power cylinder is attached to said chain sprocket and is operable to raise and lower said sprocket and said chain therewith, the flow of pressurizing fluid to said power cylinder in a direction to lower said sprocket, chain and carrier means being controlled by said control switch.

4. A material handling machine as defined in claim **1** wherein:

said material pickup means comprises a plurality of vacuum cups connected to a vacuum source, said cups being adjustably mounted on said lift head for shifting movement longitudinally and transversely of said lift head, whereby said vacuum cups may be adjusted on said lift head to pick up varying numbers of pieces of different sizes.

5. A material handling machine as defined in claim **1**, and further including a receiving bed on which material is received and accumulated to be picked up by said machine;

displaceable material stop means at a predetermined location on said receiving bed for stopping pieces of material conveyed onto and along said bed at a predetermined point thereon; and

a control switch mounted adjacent to said stop means and operable in response to the displacement of said stop means to actuate said drive means for movement in said opposite direction to lower said lift head.

6. Material handling apparatus comprising:

a horizontally shiftable carriage on an elevated, horizontal guide track;

reversible motor means drivingly associated with said carriage and operable to move said carriage back and forth on said track;

a lift head mounted on said carriage for vertical movement upwardly and downwardly, said lift head being horizontally shiftable with said carriage;

material pickup means on said lift head;

means for raising said lift head;

a motor means control device operative to initiate movement of said motor means in one direction to shift said carriage in a predetermined, horizontal direction on said track;

a supply station at which pieces of material to be picked up by said material handling machine are deposited;

a stacking station at which material picked up from said supply station by said machine is stacked;

a signal emitter positioned to send a signal along a horizontal path which intersects the vertical direction of extent of a stack of material accumulating at said stacking station and on which said material handling machine is placing pieces of material picked up from said supply station;

a signal sensing device mounted on said lift head and operative in response to a signal received from said signal emitter to deactivate said lift head raising means and to actuate said motor means control de-

vice to initiate movement of said carriage in said predetermined direction, whereby, with said lift head moving upwardly with a piece of material picked up from said supply station, the stack of material accumulating at said stacking station will interfere with the transmission and reception of said signal by said emitter and sensing device and said sensing device will not deactivate said lift head raising means and actuate said motor means control device until said lift head and said sensing device thereon have been elevated to a level above the top of the stack of material accumulating at said stacking station.

7. Material handling apparatus as defined in claim **6** wherein:

said motor means control device is electrically operable;

said signal emitter is a light source; and

said sensing device is a photoelectric cell operative to open and close a circuit to said control device.

8. Material handling apparatus as defined in claim **7** wherein:

a height control limit switch is interposed in said circuit with said photoelectric cell and said motor means control device and is operative in response to the elevation of said lift head to a predetermined minimum clearance height to close a set of contacts in said circuit to said motor control device.

9. Material handling apparatus as defined in claim **6** wherein:

said apparatus includes means for lowering said head;

said stacking station is comprised of first and second material receiving stations; and

first and second limit switches spaced apart along the length of said track in substantially vertical alignment with said first and second material receiving stations respectively, each of said limit switches being operative in a control circuit in response to contact by said carriage to actuate said lift head lowering means, said limit switches being connected in a logic circuit of said control circuit in such a manner that only one of said switches is in said control circuit at a time, whereby said limit switches alternately actuate said lift head lowering means in response to contact by said carriage to cause the alternate lowering of said lift head at first one and then the other of said material receiving stations to stack pieces of material at said stations.

10. Material handling apparatus comprising:

a material handling machine having a lift head movable upwardly and downwardly;

material pickup means on said lift head;

means for lowering said lift head to pick up material;

a receiving bed on which material is received and accumulated;

material stop means at a predetermined location on said receiving bed for stopping pieces of material conveyed onto and along said bed at a predetermined point thereon;

a control device positioned at a location adjacent to said receiving bed which is a predetermined distance forwardly of said stop means in the direction from which material is received, such that the distance between said stop means and said control device is substantially equal to a predetermined total length of material to be accumulated on said bed, said control device including a time delay relay and being operative in response to the presence of material on said bed at said location for a predetermined period of time to actuate said means for lowering said lift head to pick up the material accumulated on said bed, said time delay relay being set to permit short lengths of material to move past said control device location onto said bed towards said stop means without activating said control device, whereby said control device will not actuate said means for lowering said lift head until a plurality of pieces of material or a single piece of material having a length equal to said predetermined total length have accumulated on said receiving bed.

11. Material handling apparatus as defined in claim **10** wherein:

said control device is a light-sensitive photoelectric cell controller having at least a portion thereof so positioned under said receiving bed at said location that the presence of material on said bed at said location will block the transmission of light to said controller and thereby initiate the lift head control function of said photoelectric cell controller.

12. Material handling apparatus as defined in claim **10** wherein:

said material stop means is longitudinally adjustable on said receiving bed towards and away from said control device to permit adjusting the distance therebetween for the particular length of material desired to be accumulated on said receiving bed.

13. Material handling apparatus as defined in claim **10** wherein:

said pickup means on said lift head comprises a plurality of material holding devices adjustably mounted on said lift head for movement longitudinally thereof in a direction extending lengthwise of said receiving bed, whereby said pickup means may be spaced and positioned on said lift head to pick up different sizes and accumulated lengths of material from said receiving bed.

14. Material handling apparatus as defined in claim **10** wherein:

said means for lowering said lift head comprises vertically shiftable carrier means attached to said lift head and bidirectional drive means drivingly associated therewith, there being sufficient free play between said drive means and said carrier means that when said pickup means engages material on said receiving bed on the downward stroke of said lift head to thereby remove stress normally exerted on said drive means by said carrier means, said drive means will be freely movable through a limited distance;

spring means engaging said drive means and maintained in a normally loaded condition by the stress normally exerted on said drive means by said carrier means;

a control switch operable in one position to stop the movement of said drive means in a direction lowering said carrier means and lift head, said switch having an actuator disposed in proximity to said drive means; and

a trip device for said switch actuator carried on said drive means, the unloading action of said spring when said pickup means strikes material on said receiving bed serving to move said drive means through said limited distance to thereby carry said

trip device into engagement with said switch actuator and move said switch to said one position wherein it stops the movement of said drive means in said lift head lowering direction.

15. A material handling machine comprising:

a horizontally shiftable carriage on an elevated horizontal guide track;

reversible motor means drivingly associated with said carriage and operable to move said carriage back and forth on said track;

a motor means control device operable to initiate movement of said motor means in one direction to shift said carriage in a predetermined, horizontal direction on said track;

a lift head mounted on said carriage for vertical movement upwardly and downwardly, and horizontally shiftable with said carriage;

material pickup means on said lift head;

means for lowering said lift head;

a work station at a first location along said guide track;

first and second material handling stations adjacent to each other at a location along said guide track between said work station and one end of said guide track at which the same material stacking or picking-up functions are carried out in proximity to said machine;

first and second limit switches spaced closely together along the length of said track in substantially vertical alignment with said first and second material handling stations respectively, each of said limit switches being operative in a control circuit to actuate said lift head lowering means in response to contact by said carriage as it moves in the same predetermined direction towards said first and second material handling stations, said limit switches being connected in a logic circuit of said control circuit in such a manner that only one of said switches is in said control circuit at a time, whereby said limit switches selectively and intermittently actuate said lift head lowering means in response to contact by said carriage as it moves in said predetermined direction to cause the selective and intermittent lowering of said lift head at said material handling stations to carry out the same material handling function at each of said stations.

16. A material handling machine as defined in claim 1 wherein:

said control switch has an actuator disposed in proximity to said drive means, and said trip device is carried into engagement with said switch actuator and thereby moves said switch to said one position as said drive means moves through said limited distance.

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