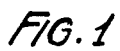


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4 Sheets-Sheet 1



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May 22, 1962

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PILE FEEDER

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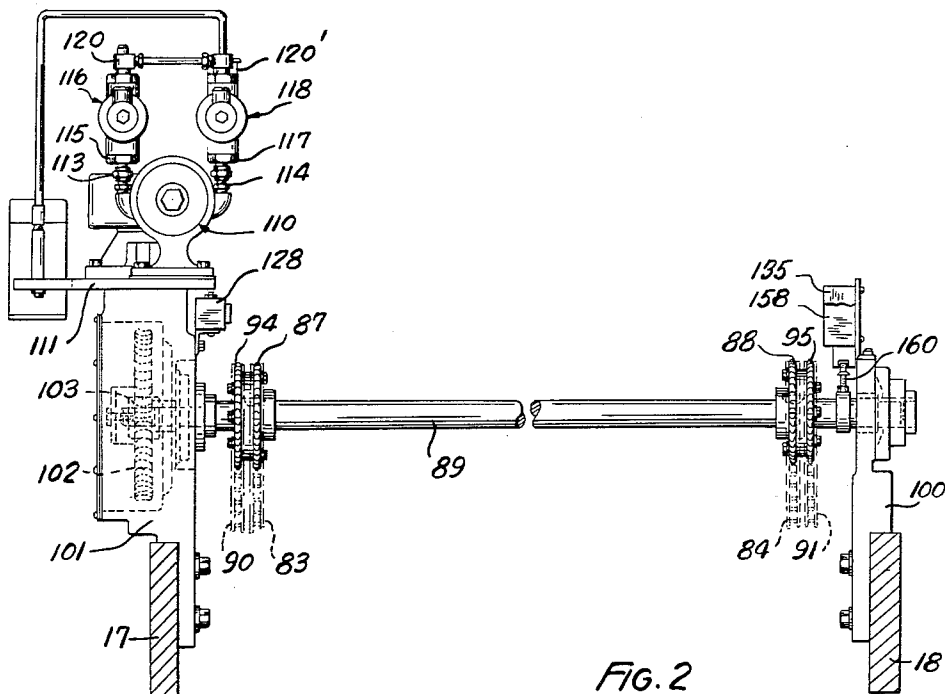


FIG. 2

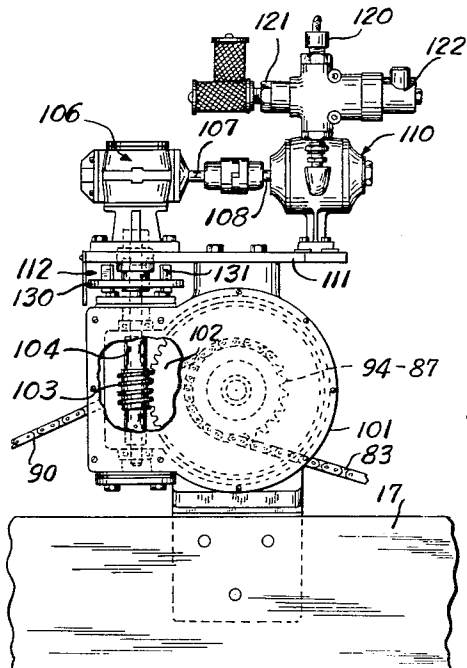


FIG. 3

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PILE FEEDER

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4 Sheets-Sheet 4

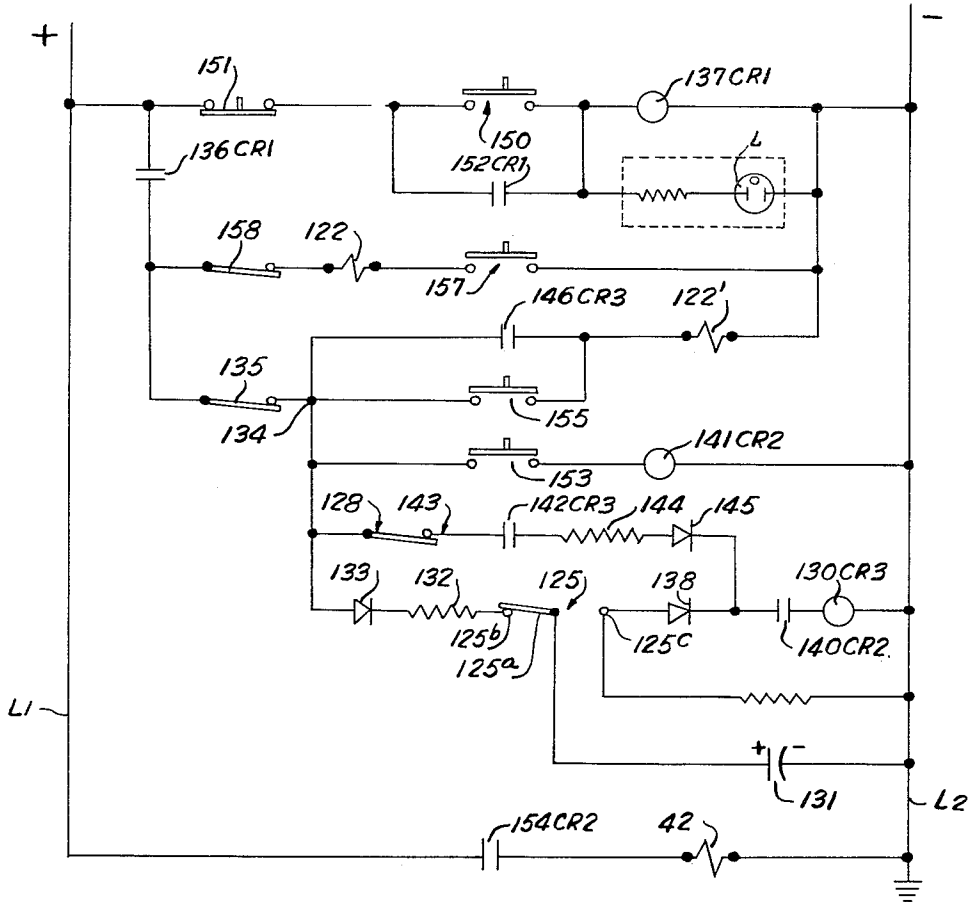


FIG. 6

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PILE FEEDER

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Filed Jan. 23, 1961, Ser. No. 84,302
12 Claims. (Cl. 271-62)

The present invention relates to pile feeders in which a pile of sheets is elevated to maintain the top of the pile between predetermined levels as the top sheets are removed therefrom and, particularly, to the type of pile feeder where two elevators or hoists are provided so that the pile can be replenished without interrupting the sheet feeding operation.

In pile feeders having two hoists or elevators for handling piles of sheets to be fed, the first pile to be fed is initially placed on a main hoist or elevator and raised by the main hoist or elevator, as the sheets are being taken therefrom, to maintain the top of the pile between predetermined levels. When the pile approaches depletion, the first pile is transferred to the other hoist or elevator, commonly termed an auxiliary hoist, and the auxiliary hoist then functions to support the pile as sheets are being taken from the top thereof and to periodically raise the pile to maintain the top between said predetermined levels. While the auxiliary hoist is supporting the pile from which sheets are being fed, the main hoist is lowered to receive a new pile and then raised to position the top of the new pile below the bottom of the pile on the auxiliary hoist. The pile on the auxiliary hoist is supported by a removable support and this support is withdrawable to allow the pile on the auxiliary hoist to drop onto the new pile on the main hoist to combine the piles. After the piles are combined, the cycle of operation may be repeated.

The auxiliary hoist is normally raised and lowered by actuating means separate from the actuating means for raising and lowering the main hoist since the hoists must be operable independently of each other. In one type of drive which has heretofore been provided for the auxiliary hoist, an electric motor is selectively operated to effect a continuous raising or lowering of the hoist or to elevate the auxiliary hoist a predetermined increment in response to a signal from a pile height detector which senses the top of the pile on the hoist.

In a known type of pile feeder, the auxiliary hoist comprises a pair of horizontal bars extending transversely of the direction of sheet feed at the front and the rear of the feeder. These bars are suspended by flexible cables which are wound onto or unwound from a drum rotated by an electric motor. The horizontal bars are adapted to pick up a pile from the main hoist by engaging pile support means disposed between the pile and the pile supporting platform of the main hoist and projecting outwardly from the main hoist platform at the front and rear thereof. Commonly, the projecting pile support means is comprises of a plurality of rods or swordlike members which are inserted beneath the pile while the pile is disposed upon a pile board supported by the main hoist and while the latter is being operated by the pile feeder.

It is desirable that the bars of the auxiliary hoist be guided in their vertical movement, but if the bars are limited to movement in a vertical plane, the pile supporting means cannot be inserted beneath the pile on the main hoist until after the main hoist has been elevated to a position above the bars of the auxiliary hoist. The insertion of the bars will take a certain period of time and during this period of time the main hoist will be elevated periodically as the top sheets are taken therefrom. When thick sheets, for example cardboard, are being fed at relatively high speeds, the main hoist will have been

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elevated considerably between the time that the insertion of the pile supporting means is started and the time that it is completed. The auxiliary hoist must now be raised at a rate which will overtake the main hoist in order to engage the bars of the auxiliary hoist with the pile supporting means projecting from the main hoist.

The speed of the motor for the auxiliary hoist must be such as to enable the auxiliary hoist to rapidly overtake the pile supporting means on the main hoist under the conditions of feeding where the main hoist is being elevated at its maximum rate under the control of the pile height detector. If a substantial length of time is involved in the overtaking of the main hoist, the operator is hurried during the rest of the pile change-over. Available change-over time is limited because the change-over cannot generally be initiated until the pile on the main hoist has been substantially depleted. Consequently, any decrease in the period of time necessary to overtake the main hoist by the auxiliary hoist is beneficial.

If a single speed auxiliary motor is provided which operates at the most desirable rate to effect a raising of the auxiliary hoist at the most desirable rate to overtake the main hoist under the conditions when the main hoist is being elevated at its maximum rate, the motor must operate at a speed such that the inertia of the rotor of the motor will present considerable problems when the motor is operated at the corresponding speed in response to the pile height detector to effect an incremental raising of the auxiliary hoist. The incremental raising of the auxiliary hoist in response to a low pile detection is to be in the order of a small fraction of an inch and if a high-speed electric motor is used, the inertia of the motor presents problems in trying to limit the raising of the auxiliary hoist to the desirable small increment.

While it might be possible to provide a two-speed electric motor to effect a fast raising of the auxiliary hoist during the overtaking of the main hoist and a slower raising of the hoist in response to the low pile detection, such an arrangement involves considerable expense.

Accordingly, an important object of the present invention is to provide a new and improved pile feeder wherein the auxiliary hoist is driven by an air motor which, when connected to a source of air pressure, effects a fast operation of the auxiliary hoist when the auxiliary hoist is not under load enabling the auxiliary hoist to quickly overtake the main hoist and effects a slower operation of the auxiliary hoist when under load.

Another object of the present invention is to provide a new and improved pile feeder in which the auxiliary hoist is operated by a motor which rotates at a fast speed to operate the hoist when the hoist is not under load and at a slower speed when under load, and in which the inertia of the rotor of the motor is so negligible that it does not adversely affect the operation of the hoist or the design considerations.

Yet another object of the present invention is to provide a new and improved pile feeder having a hoist, particularly an auxiliary hoist, operated by a direct drive from a rotary motor, and which can be stopped in response to signals more quickly than the hoists, particularly the auxiliary hoists, in present feeders, thereby enabling the hoist to be raised a smaller increment than heretofore possible.

Another object of the present invention is to provide a new and improved pile feeder having main and auxiliary hoists and in which the auxiliary hoist is periodically elevated to maintain the top of a pile thereon at a predetermined level and raised and lowered selectively by the operation of a low torque, high-speed air motor which is connected to raise and lower the auxiliary hoist through self-locking reduction gearing so that the direction of drive is not reversible.

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A further object is to provide a new and improved hoist having a control for operating the hoist in response to the momentary actuation of a switch wherein the operation of the switch disconnects a condenser from a charging circuit and connects it across a relay energizable to effect hoist operation.

Further objects and advantages of the present invention will be apparent from the following detailed description of the preferred embodiment thereof made with reference to the accompanying drawings forming a part of the present specification for all matter shown therein, and in which:

FIG. 1 is a perspective view, somewhat diagrammatic, showing a pile feeder embodying the present invention;

FIG. 2 is an elevational sectional view of the pile feeder shown in FIG. 1 showing the drive mechanism for raising and lowering the auxiliary hoist;

FIG. 3 is a view looking at the left-hand side of the apparatus shown in FIG. 2;

FIG. 4 is a fragmentary rear elevational view showing the details of the pile height detector used with the feeder shown in FIG. 1;

FIG. 5 is a diagrammatic view showing the mechanism operated by the pile height detector to effect the raising and lowering of either the auxiliary hoist or the main hoist; and,

FIG. 6 is a circuit diagram of the disclosed embodiment showing the circuit for controlling the auxiliary hoist.

Referring to the drawings, FIG. 1 shows a pile feeder which has main and auxiliary hoists so that the pile being fed can be replenished without interrupting the feeding operation. The main hoist of the pile feeder is designated generally by the reference numeral 10, while the auxiliary hoist is designated generally by the reference numeral 11. It will be understood that the pile feeder includes sheet separating mechanism for separating and taking the top sheet from the pile. Since the sheet separating mechanism does not per se form a part of the present invention, it has not been shown in detail in the drawings, nor will it be described. Suffice it to say that the sheet separating mechanism may comprise suckers 13 which are periodically lowered to pick up the top sheet and to lift the sheet to forwarding suckers 14 disposed above the pile. The forwarding suckers take the sheet from the separating suckers 13 and advance the sheet in a forward direction, which is the direction of the arrows in FIG. 1.

The main hoist 10 may comprise a platform 16 supported from overhead rails 17, 18 which extend in the direction of sheet feed. The platform 16 is supported from the overhead rails 17, 18 by cables 20 adjacent each of the four corners of the platform 16 and which pass over pulleys 21 on the overhead rails 17, 18 and are wound on drums 22 on a shaft 23 at the front of the feeder. The near end of the shaft 23, as viewed in FIG. 1, is cut away but it is understood that the cables 20 on the near side of the feeder are wound on drums on the shaft 23 and correspond to the drums upon which the cables on the far side of the feeder are wound. The shaft 23 is rotatable in one direction to wind the cables 20 onto the drums 22 to raise the main hoist and in the opposite direction to unwind the cables 20 from the drums 22 and lower the main hoist. The shaft 23 may be rotated in its direction to raise the main hoist by a pawl and ratchet mechanism 24. The pawl and ratchet mechanism 24 includes a ratchet wheel 25 secured to a shaft 26 extending parallel to the shaft 23 at the front of the feeder and a pawl 27 pivoted to one end of an arm of a bellcrank lever 28 rotatably mounted on the shaft 26. The pawl 27 (FIG. 5) is reciprocated by a link 29 having one end connected to the bellcrank lever 28 and the other end to a crank member 31. The crank member 31 is continuously rotated to effect a continuous reciprocation of the pawl 27. The pawl 27 may be swung to an inoperative position by lifting a mask or pawl lift member 33 which

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engages a roller 34 on the pawl 27 and may be lowered to an operative position by lowering the mask member 33. When the pawl 27 is in its inoperative position, the pawl will merely reciprocate along the mask member without engaging the ratchet teeth on the wheel 25, but when the mask member 33 is lowered, the pawl 27 is moved to an operative position where it will engage the ratchet teeth on the pawl 25 and effect an incremental rotation of the wheel for each reciprocation of the pawl 27.

The mask member 33 is pivoted for movement between a raised position and a lowered position by a pivot pin 36 and is swung counterclockwise about the pin 36 to lower the pawl to its operative position and is moved clockwise about the pin 36 to raise the pawl 27 to its inoperative position.

The mask member 33 is weight-biased in a counterclockwise direction to tend to move toward the operative position for the pawl 27 and may be held in its raised position by a bellcrank lever 38 which has an arm 39 that engages an upwardly extending arm 46 of the mask member 33, or the mask member 33 may be raised to and held in its raised position by energizing a solenoid 42 having an armature connected to the mask 33 by a rod 42a.

The bellcrank lever 38 is operated under the control of a pile height detector 40 to effect a lowering of the mask 33 when the pile height detector 40 indicates a low level of the pile being fed. To this end, the bellcrank lever 38, has, in addition to the arm 39, an arm 47 which carries a cam follower 43 that engages a cam 44 which is continuously rotated. The cam 44 will effect a continual reciprocation of the bellcrank lever 38 to repeatedly raise and lower the mask 33 provided the bellcrank lever 38 is free to follow the cam 44. The bellcrank lever 38 is biased in a clockwise direction about its pivot, as viewed in FIG. 5, by a spring 45 so that the lever tends to follow the cam 44. The bellcrank lever 38 has a plate 48 fixed thereto which normally engages the lower end of a generally vertically extending latching member or lever 50 which is part of a rocker member 51. When the lower end of the latching lever 50 is in engagement with the plate 48, the bellcrank lever 38 cannot rock to follow the cam 44 as it is rotated from a position where the high point of the cam is in engagement with the cam follower 43 to a position where the low part of the cam engaged is opposite the follower 43. The rocker member 51 may, however, be swung about its pivot to swing the latching lever 50 clockwise as viewed in FIG. 5 to clear the plate 48 and allow the bellcrank lever 38 to follow the cam 44 under the action of the spring 45. When this happens, the lever arm 39 moves clockwise, as viewed in FIG. 5, to allow the mask 33 to drop the pawl 27 to engage the wheel 25 as the pawl is reciprocated to effect an indexing of the index wheel 25.

The position of the rocker member 51 and, in turn, the latching lever 50 is controlled by the pile height detector 40. As is shown in FIGS. 1, 4 and 5, the pile height detecting means comprises a detecting finger 53 which extends generally vertically and which is threaded into a support block fixed to the end of a detecting arm 54 rockable on a shaft 55 extending transversely of the pile elevating mechanism and stationary during the operation of the elevating mechanism.

The detecting arm 54 and, in turn, the detecting finger 53 are rocked toward engagement with the top rear edge of the pile from which sheets are being taken once during each cycle of operation, a cycle of operation occurring between the times each sheet is removed from the pile. The rocking of the detecting arm 54 is accomplished, in the illustrated embodiment, by means of a cam 57 which is fixed to a continuously rotating cam shaft 56 disposed immediately above the shaft 55 which supports the detecting arm 54. The cam 57 cooperates with a cam follower 58 fixed to a portion of the detecting arm on the side of the shaft 55 remote from the detecting finger 53 to

effect an oscillation of the detecting arm 54. The follower 53 is urged into engagement with the cam 57 by a spring 59 connected between the detecting arm 54 and a cam guard fixed to a stationary shaft 60 above and parallel to the shafts 55, 56. When the cam 57 is rotated, the cam has a low portion which allows the spring 59 to move the detecting arm 54 counterclockwise about the rockshaft 53, as the latter is viewed in FIG. 5, to move the detecting finger 53 downwardly toward engagement with the top of the pile. If the detecting finger 53 engages the top of the pile, the cam follower 58 will not follow the cam 57 and the rocking movement will stop until the high portion of the cam 57 again lifts the detecting finger 53 from the pile when the high portion thereof engages the cam follower 58 to move the detecting arm 54 in a clockwise direction as viewed in FIG. 5. If the height of the pile is such as to allow the cam follower 58 to follow the cam when it is riding toward the low portion the arm 54 rocks an angular amount which is greater than when the level of the pile is such as to prevent the follower from following the cam 57.

When the detecting arm 54 rocks on its shaft 55, a detector rockshaft 63 extending parallel to the shaft 55, but rearwardly thereof and downwardly therefrom, is rotated or rocked an angular amount corresponding to the rocking of the detecting arm 54. The shaft 63 has an arm 64 keyed thereto and extending upwardly therefrom with the upper end of the arm being connected to the detecting arm 54 by a link pivoted to the arm 64 and to the rocker member 54 on the axis of the cam follower 58. It can be seen, therefore, that the angular rotation of the shaft 63 is indicative of the height of the pile and the adjustment of the detector is such that when the shaft 63 rocks a predetermined angular amount, it is a signal that the pile height is too low.

The end of the shaft 63 adjacent the overhead rail 17 has fixed thereto an arm 67 which carries a roller 68 at its outer end that is engageable with a laterally extending flange 69 on a shaft 70 that extends parallel to the overhead rail 17 from the rear to the front of the feeder. When the shaft 63 is oscillated, the arm 67 moves downwardly to engage the flange 69 of the shaft 70 to effect a corresponding angular movement of the shaft 70. The angular movement of the shaft 70 controls the pawl lift or mask member 33. The shaft 70 is connected to control the pawl lift or mask member 33 so that when it rotates to move the flange 69 downwardly to a predetermined angular position, the pawl 27 is allowed to engage the ratchet wheel 25 and when it is rotated in the opposite direction a predetermined amount from the position where the pawl 27 is engageable with the wheel 25, it prevents engagement of the pawl 27 with the ratchet wheel 25. To this end, an arm 71 (see FIG. 1) is fixed to the forward end of the shaft 70 and extends radially outwardly therefrom and inwardly of the elevating mechanism. A rod 72 is adjustably connected to the outer end of the arm 71 so as to move therewith and extends downwardly therefrom to effect the rocking of the vertical latch member 50 in accordance with the rocking of the shaft 70. The latch member 50 has a rearwardly extending arm 75 which is connected to the rod 72 by a noddle pin connection 76. A setscrew adjustable fixes the noddle pin 76 to the rod 72. A spring 77 is disposed about the rod 72 and engages the noddle pin and a frame member through which the lower end of the rod 72 freely slides. The spring 77 urges the rod 72 upwardly, and in turn, the latch member 50 in a counterclockwise direction, as viewed in FIG. 5, and the shaft 70 correspondingly. The flange 69 on shaft 70 is therefore urged toward engagement with the roller 68 rocked by the detector shaft 63.

From the foregoing, it can be understood that when the level of the pile being detected by the pile height detector 40 falls below a predetermined lower limit, the downward angular movement of the detecting finger 53 will be sufficiently far to rock the latching member 50

out of its position where it holds the bellcrank lever 38 in the position shown in FIG. 5 to allow the lever 38 to follow the cam 44. Consequently, as the low part of the cam 44 is rotated to a point opposite to the roller 43, the bellcrank lever 38 will be rocked clockwise, as is shown in FIG. 5, to drop the pawl mask member 33 and to allow the pawl 27 to index the wheel 25. Conversely, if the angular movement of the detector arm 54 is not sufficient to move the latching member 50 clear of the plate 48 on the bellcrank lever 38, the mask member 33 will not be lowered to allow the pawl 27 to effect an indexing of the index wheel 25.

The auxiliary hoist which takes the partially depleted pile from the main hoist 10 is shown, in the illustrated embodiment, as comprising a pair of transverse front and rear bars 80, 81, respectively, which extend across the feeder and which have their opposite ends received in guides 82 depending from the overhead bars 17, 18 and adapted to guide the transverse bars 80, 81 in their vertical movements. The transverse bar 81 is suspended from the overhead rails 17, 18 by flexible connectors 83, 84, chains in the illustrated embodiment, connected to the opposite ends of the bar. The chain 83 passes over an idler sprocket 85 supported by the overhead rail 17 and the chain 84 passes over an idler sprocket 86 supported by the rail 18. The chains 83, 84 are wound on sprockets 87, 88, respectively, to the opposite ends of a shaft 89 extending across the feeder and rotatably supported at one end in a bracket 100 fixed to the overhead rail 18 and at the other end in a casting 101 secured to the overhead rail 17. When the shaft 89 is rotated in one direction, the chains 83, 84 are wound on the sprockets 87, 88 to raise the transverse bar 81 and when rotated in the opposite direction, the chains are unwound to lower the transverse bar 81.

The transverse bar 80 at the front of the feeder is supported in a manner similar to the transverse bar 81 and, as may be seen by reference to the drawing, chains 90, 91 are connected to the opposite ends of the bar 80 and pass over sprockets 92, 93, respectively, mounted on the overhead rails 17, 18 and are wound on sprockets 94, 95, respectively, fixed to the shaft 89 adjacent the sprockets 87, 88. The chains are wound on the sprockets 94, 95 so that the bar 80 is raised and lowered with the bar 81 upon rotation of the shaft 89.

The end of the shaft 89 which is journaled in the casting 101 has a worm wheel 102 fixed thereto. The worm wheel 102 is disposed within the casting 101 and is driven by a worm 103 fixed to a vertical shaft 104 which extends upwardly from the worm 103 and is connected to the output shaft of a reduction unit 106. The reduction unit 106 has an input shaft 107 which is driven from the rotor shaft 108 of a reversible, rotary air motor 110. Rotary air motors of the type shown are fundamentally low torque, high-speed motors and the rotors thereof have a low inertia, particularly as compared to the inertia of an electric motor. The rotary air motor 110 and the reduction unit 106 are mounted on a plate 111 which is secured to the top of the casting 101. The casting 101 is formed to provide a space 112 between the plate 111 and the casting 101 immediately below the reduction unit 106 for purposes which will be explained hereinafter.

The air motor 110 has connections 113, 114 which are adapted to provide fluid connections to the opposite sides of the rotor of the motor. The connection 113 of the air motor 110 is connected to a controlled port connection 115 of a three-way solenoid valve 116, while the connection 114 of the motor 110 is connected to a port connection 117 of a three-way solenoid valve 118. The solenoid valve 116 is a conventional three-way valve and has a port connection 120 which is connected to a source of air under pressure and a port connection 121 which is connected to atmosphere or exhaust. The valve includes a valve member which is operated by a solenoid 122 and when the solenoid is de-energized, the valve member is in

a position where the port connection 120 is blocked and the port connections 115, 121 are interconnected to connect one side of the motor to atmosphere through the motor connection 113, the port connection 115, and the port connection 121. When the solenoid 122 is energized, the valve member is rotated to a position connecting the port connection 120 to the port connection 115 and blocking the exhaust connection 121. The solenoid valve 118 has similar port connections to the connections 120, 121 and a solenoid corresponding to the solenoid 122 and these parts of the valve 118 have been given the same reference numeral as the corresponding parts of the solenoid valve 116 with a prime applied thereto. As is conventional, the ports of the valves 116, 118 that are connected to the motor and to exhaust have larger areas than the ports connected to the source of air pressure.

It can now be seen that by energizing the solenoid valve 116, the rotary air motor 110 will have air pressure applied to one side thereof to rotate the motor in one direction and by energizing the solenoid valve 118, the air motor 110 will have air pressure applied to the opposite side thereof to rotate the motor in the opposite direction. When the solenoid valve 116 is energized, the motor rotates in a direction to lower the auxiliary hoist and when the solenoid valve 118 is energized, the motor rotates in a direction to raise the auxiliary hoist.

The rotary air motor is a relatively high-speed, low torque motor and the reduction gearing between the motor and the shaft 89 is a high ratio reduction gearing, for example, 1920 to 1, to obtain the necessary low speed, high torque. Furthermore, the high reduction enables the air motor to be rotated a number of revolutions, for example, ten, to raise the auxiliary hoist a small increment, for example, .078", in response to a signal from the pile height detecting means, thereby providing a fine control. Furthermore, the worm 193 and the worm wheel 192 provide a self-locking drive which prevents the direction of drive from being reversed and the auxiliary hoist from dropping when both sides of the air motor 110 are connected to atmosphere or exhaust. It will also be noted that the gear reduction unit 106, and the worm and worm wheel drive will provide considerable frictional resistance to the operation of the motor 110 so that, when air pressure is removed from the motor 110, the low inertia rotor thereof will be quickly stopped.

Preferably, the solenoids 122, 122' can be controlled by the operator to effect a continuous raising and lowering of the hoist or may be selectively controlled by the pile height detector 40 to effect an incremental raising of the hoist in response to a low pile height detection. To this end, a switch 125 is mounted adjacent the bellcrank lever 38 and has an actuator 126 which is biased into engagement with the arm 39 of the lever 38. When the bellcrank lever is rocked, the actuator 126 is depressed to momentarily close the switch 125 which has a set of normally-open and a set of normally-closed contacts. When the switch 125 is actuated and the circuit is conditioned for control by the detector 40, the solenoid 122' is energized to actuate the valve 118 to supply air to the motor 110 to effect a raising of the hoist and the valve will remain energized until a holding circuit for the solenoid is broken by the actuation of a switch 128. The switch 128 is a proximity switch which is mounted adjacent the space 112 between the plate 111 and the casing 101 and through which the shaft 104 passes. The shaft 104 carries a circular plate 130 which has mounted thereon a plurality of spaced ferromagnetic lugs 131; three lugs are shown in the illustrated embodiment spaced 120 degrees apart. Whenever one of the lugs 131 rotates past the switch 128, the ferromagnetic nature of the lugs causes the switch 128 to be actuated to deenergize the solenoid 122' and stop operation of the motor 110. Consequently, it will be seen that for each actuation of the switch 125 the auxiliary hoist will be raised an increment

which is produced by one-third of a rotation of the shaft 104.

In the examples mentioned hereinbefore, the reduction between the air motor 110 and the shaft 89 was 1920:1. This can be provided by a gear reduction of 30:1 in the unit 106 and a reduction of 64:1 in the worm 103 and worm wheel 102. In this event, the motor 110 will rotate approximately 10 revolutions for each 120 degrees of movement of shaft 104 and plate 130 and this rotation will raise the auxiliary hoist about .078".

FIG. 6 is a simplified control circuit for the preferred embodiment disclosed herein. Referring to FIG. 6, it will be noted that the switch 125 is in a circuit for controlling a relay 130CR3. The switch 125 is shown as including a switch arm 125a which is normally in contact with a contact 125b and which, when the plunger 126 is actuated, is moved into engagement with a contact 125c. The switch arm 125a is connected to one side of a condenser 131 which has its other side connected to L2, which is one side of a power supply, the other side of the power supply being designated by the reference character L1. The contacts 125b of the switch 125 is connected through a resistance 132 and a diode 133 to a junction 134 which is, in turn, connected to L1 through a normally closed limit switch 135 and normally open contacts 136CR1 of a relay 137CR1. As will be apparent from the description hereinafter, the contacts 136CR1 are closed when the circuit is to be operated upon the control of the pile height detector so that the junction 134 is at L1 and the condenser 131 will be charged through a circuit comprising the diode 133, the resistor 132, and the switch arm 125a when the switch 125 is in its nonactuated position where it engages contacts 125b. When the switch 125 is actuated and the switch arm 125a is moved into engagement with the contact 125c, the voltage of the condenser 131 is applied to energize the relay 130CR3. The relay 130CR3 is connected to the contact 125c by a diode 138, which is connected directly to the contact 125c, and a series connection including the normally open contacts 140CR2 of a relay 141CR2. The relay 141CR2 is energized when the circuit is conditioned to be operated in response to the pile detector and the contacts 140CR2 are therefore closed under this condition and the engagement of the switch arm 125a with the contact 125c is effective to energize the relay 130CR3. The energization of the relay 130CR3 closes its contacts 142CR3 in a holding circuit from the junction 134 in parallel with the diode 133, the resistor 132, the switch 125, and the diode 138 to provide a circuit for energizing the relay 130CR3 independently of the switch 125. This parallel circuit is designated by the reference numeral 143 and includes the normally closed contacts of the proximity switch 128, which are connected directly to the junction 134, the normally open contacts 142CR3, a resistor 144 and a diode 145. Consequently, when the switch 125 is actuated to pick up the relay 130CR3 by discharging the condenser 131, the picking up of the relay completes the holding circuit 143 which is broken when the proximity switch 128 is actuated after the shaft 104 rotates one-third of a revolution. It will be noted that the switch 125 is only a momentary switch, i.e., the switch is only closed momentarily in response to the reciprocation of the plunger 126 and, consequently, the switch arm 125 will be returned to its position in engagement with the contact 125b before the motor has operated to rotate the shaft 104 a third of a revolution.

The energization of the relay 130CR3 also closes its normally open contacts 146CR3 in a circuit for energizing solenoid 122' for supplying air to the air motor. The solenoid 122' is connected to L2 and to the junction 134 through the normally open contacts 146CR3 of relay 130CR3. Consequently, the energization and de-energization of the relay 130CR3 effects the energization and de-energization of the solenoid 122' to start and stop the air motor.

When the circuit is to be operated in response to the

pile height detector, a "Power On" selector switch 150 is actuated to momentarily connect the relay 137CR1 to L1 through a "Power Off" or "stop" pushbutton switch 151, the switch 151 normally being closed. The energization of the relay 137CR1 closes its contacts 136CR1 to apply L1 to the junction 134 and also closes holding contacts 152CR1 connected in parallel with the switch 150 to maintain the relay 137CR1 energized, as well as an indicator light L. The relay 141CR2 is then energized by depressing a push button switch 153 which connects one side of the relay 141CR to the junction 134 to effect energization of the relay. Energization of the relay 141CR2 closes its contacts 140CR2 in the circuit for energizing the relay 130CR3 to condition this relay to be energized when the switch 125 is actuated. The relay 141CR2 also has contacts 154CR2 closed by the energization of the relay to energize the solenoid 42 to prevent the dropping of the mask member 33.

After the pushbutton switch 150 has been actuated to energize relay 137CR1 and supply power to the junction 134, the auxiliary hoist can be raised and lowered independently of the operation of switch 125. To this end, a pushbutton switch 155 is connected in parallel with the contacts 146CR3 between the junction 134 and the air raise solenoid 122' so that when the switch is depressed, the solenoid 122' is energized to effect a raising of the auxiliary hoist as long as the switch is held depressed. Similarly, the solenoid 122 can be energized by depressing a switch 157 for connecting one side of the air solenoid 122 to L2 to effect the lowering of the hoist. Preferably, the air solenoid 122 is connected to L1 through the normally closed contacts of a limit switch 158 which is operated when the auxiliary hoist reaches the bottom limit of its travel. It can also be seen from the diagram that operation of the limit switch 135 at the top limit of travel will disconnect the junction 134 from L1 to open any circuit for energizing solenoid 122'. These switches are mounted on the bracket 100 above the shaft 89 and a dog 160 on the shaft 89 operates the switches as the dog approaches a vertical position. It will be recalled that the shaft 89 is rotated somewhat less than a complete revolution to effect the full raising and lowering of the auxiliary hoist. Consequently, when the shaft is being rotated in a clockwise direction, as viewed from the near end in FIG. 1, the dog 160 thereon will effect an actuation of the switch 153 as the shaft 89 is rotated to its limit position corresponding to the lower position of the hoist and will operate the switch 135 as the shaft is rotated counterclockwise to raise the hoist when the shaft 89 reaches its limit position corresponding to the upper position of the hoist 11.

In operation, the main hoist 10 is lowered to position the platform 16 in a recess in the floor to enable a pile to be fed to be placed on the main hoist by placing a palletized pile onto the main platform. The main hoist 10, after the pile is positioned thereon and the main hoist is raised to a feeding level, is operated under the control of the pile height detector to raise the main hoist periodically to maintain the top of the pile within predetermined limits as the sheets are taken therefrom. When the pile has been partially depleted, and the main hoist has reached a position above the lower limit of the auxiliary hoist, a plurality of support members 161 are inserted underneath the partially depleted pile on the main hoist. These support members are indicated in FIG. 1 and project beyond the platform at both the front and the rear sides of the pile. After the support members have been inserted, the auxiliary hoist 11 is raised to pick up the projecting ends of the support members with the projecting ends resting on the transverse bars 80, 81 and the auxiliary hoist is placed under the control of the pile height detector 40. When the pile height detector 40 indicates that the auxiliary hoist is to be raised, the switch 125 will be actuated in the manner described above to effect an energization of the air solenoid 122 and the air motor will operate until

the proximity switch 128 is operated to interrupt the holding circuit for the relay 130CR3.

It will be noted that the temporary support members 161 cannot be inserted until after the bottom of the pile on the main hoist 10 is elevated to a position above the transverse bars 80, 81. If the temporary support members were inserted before this level, the projecting ends of the support members 161 would hang up on the bars 80, 81 as the main hoist was elevated to move the pile and the support members 161 in position to be picked up by the auxiliary hoist. The temporary support members 161 are inserted one at a time and while this insertion is occurring, the main hoist is being elevated under the control of the pile height detector. Consequently, by the time that the operator inserts the temporary support members 161, the main hoist will have been elevated to a position above the bars 80, 81 and the auxiliary hoist must be operated to overtake the main hoist as the latter operates under the control of the pile height detector. If cardboard is being fed or other thick sheets, the upward movement of the main hoist under the control of the pile height detector will be at a relatively rapid rate and the auxiliary hoist must be operated at a considerably higher rate if it is to overtake the main hoist in a reasonable amount of time. Since the pile on the main hoist is continually being depleted, it is desirable that the time consumed in overtaking the main hoist during the change-over operation be held to a minimum.

The air motor 110 will operate at a considerably higher rate when it is not under load than when it is under load, and in practice it has been found that the air motor will operate in excess of five times as fast when it is not under load, and as much as ten times as fast, depending upon the size of the feeder and the size of the normal load. Accordingly, the air motor during the overtaking operation will operate at a high rate of speed which will be as much as five times as fast as the speed at which it operates during normal operation. After the air motor 110 picks up the load, the air motor will operate at a slower speed but a speed sufficiently fast to effect the necessary elevation of the pile in response to the pile height detector. Accordingly, it can be seen that the present invention provides a motor which will operate at a high speed when the high speed is desirable and yet will operate at a sufficiently high enough speed under load during the operation of the motor in response to the pile height detector to satisfactorily effect the incremental elevation of the auxiliary hoist. Accordingly, it is not necessary to provide any change-speed controls or to provide an expensive multi-speed electric motor.

While the auxiliary hoist is being operated under the control of the pile height detector, the main hoist is lowered by the power means (not shown) and a new pile is brought into position and then the main hoist is raised to a position where the top of the new pile on the main hoist is disposed immediately under the temporary supports. At this time, the temporary supports are withdrawn to deposit the pile on the auxiliary hoist onto the new pile on the main hoist and the control of the main hoist is returned to the pile height detector 40. It will be recalled that the control between the pile height detector 40 and the main hoist is connected and disconnected by energizing solenoid 42. When the solenoid 42 is energized, the pawl mask member 33 cannot be lowered in response to reciprocation of the bellcrank lever 38, and when the solenoid is de-energized, the mask member 33 will follow the reciprocation of the bellcrank lever 38 and the index wheel 24 will be indexed when the bellcrank lever 38 is reciprocated.

The mechanism for raising and lowering the auxiliary hoist has proved to be extremely satisfactory in use since the inertia of the air motor is extremely small and it is possible to quickly stop the raising of the auxiliary hoist in response to the actuation of the proximity switch 128. Moreover, it will be noted that the worm and worm

wheel provide a self-locking, power-transmitting connection which prevents the direction of drive from reversing and the auxiliary hoist from dropping when both sides of the air motor 110 are connected to atmosphere. Furthermore, the disclosed mechanism is extremely simple and economical to manufacture. The use of the air motor rather than an electric motor to elevate the auxiliary hoist eliminates the problems of heat generation due to the fact that an electric motor would be energized only for short periods of time during which it normally would draw high currents.

Specific motor speeds for the air motor have been given in the application by way of explanation and example. It will be recognized, however, that the pile being fed is being depleted at a particular rate and that if the top of the pile being fed is to be maintained at a predetermined level, the hoist on which the pile is supported must be operable to raise the pile at a rate at least as great as the rate of depletion. Therefore, the air motor 110, when the pile is on the auxiliary hoist, effects elevation of the auxiliary hoist at a rate which is at least as great as the rate of pile depletion. When the pile being fed is on the main hoist, the main hoist, under the control of the pile height detector, is being elevated at an average rate which is substantially the same as the depletion rate for the pile and since the speed of the auxiliary hoist when under the load is at least equal to the depletion rate, the "no-load" speed will be substantially greater than the rate of depletion and it can be operated to quickly overtake the main hoist.

In the preferred embodiment, the switches 150, 155 are switches which must be held closed and which open when released, while the switch 157 for effecting a lowering of the auxiliary hoist and the switch 153 for effecting operation of the auxiliary hoist under the control of the detector 40 are switches which latch in mechanically when depressed. Furthermore, the switches 150, 153, 155 and 157 are preferably mechanically interlocked, in a conventional manner, to cause any actuated switch to be released when another switch is depressed and for the switch which is released to be actuated to break its circuit before the one which is actuated makes its circuit so that no two of these switches can be depressed simultaneously.

While the invention has been illustrated in a particular feeder where higher speed operation is required, it will be appreciated that the invention is applicable in other feeders where it is desirable to provide higher speed operation when the motor is not under load.

While the preferred embodiment of the invention has been described in detail, it is hereby my intention to cover all constructions, modifications, and arrangements which fall within the ability of those skilled in the art and within the scope and spirit of the present invention.

Having described our invention, what we claim is:

1. A pile feeder in which the top sheets are removed from a pile of sheets to deplete the pile at a given rate and including pile height detecting means, a main hoist for supporting the pile to be depleted and adapted to be periodically elevated under the control of said detecting means to maintain the top of the pile thereon between predetermined levels as the top sheets are removed, and an auxiliary hoist adapted to be moved upwardly in a continual manner to overtake the main hoist and pick up the pile thereon after it has been partially depleted and as the main hoist is being elevated under the control of said detecting means to maintain the top of the pile thereon between said predetermined levels, said pile height detecting means being adapted to control the auxiliary hoist after it takes the pile from the main hoist, said auxiliary hoist including horizontal load-supporting members adapted to engage the underside of pile-supporting means projecting from said main hoist to take the pile from the main hoist, a reversible high-speed, low torque air motor, reduction gearing driven by said air motor and having

an output shaft connected to raise and lower said load-supporting members upon rotation in opposite directions, said reduction gearing being such that the rate of elevation of said auxiliary hoists by said motor when the hoist has a partially depleted pile thereon is at least as great as said given rate of depletion whereby the operation of said motor when no pile is on the auxiliary hoist is at a rate substantially greater than said given rate, and control means for selectively effecting continual operation of said motor and for selectively effecting incremental operation of said motor in response to said pile height detecting means.

2. A pile feeder in which the top sheets are removed from a pile of sheets to deplete the pile at a given rate and including pile height detecting means, a main hoist for supporting the pile to be depleted and adapted to be periodically elevated under the control of said detecting means to maintain the top of the pile thereon between predetermined levels as the top sheets are removed, and an auxiliary hoist adapted to be moved upwardly in a continual manner to overtake the main hoist and pick up the pile thereon after it has been partially depleted and as the main hoist is being elevated under the control of said detecting means to maintain the top of the pile thereon between said predetermined levels, said pile height detecting means being adapted to control the auxiliary hoist after it takes the pile from the main hoist, said auxiliary hoist including horizontal load-supporting members adapted to engage the underside of pile-supporting means projecting from said main hoist to take the pile from the main hoist, a reversible high-speed, low torque air motor, reduction gearing driven by said air motor and having an output shaft connected to raise and lower said load-supporting members upon rotation in opposite directions, said reduction gearing being such that the rate of elevation of said auxiliary hoist by said motor when the hoist has a partially depleted pile thereon is at least as great as said given rate of depletion whereby the operation of said motor when no pile is on the auxiliary hoist is at a rate substantially greater than said given rate, and control means for selectively effecting continual operation of said motor and for selectively effecting incremental operation of said motor in response to said pile height detecting means, said control means including a two-position solenoid valve having a first position connecting one side of said motor to a source of fluid pressure and a second position connecting said one side of said motor to exhaust.

3. A pile feeder wherein the top sheets are successively removed from a pile to deplete the pile at a given rate and including a main hoist and an auxiliary hoist adapted to be moved upwardly to overtake the main hoist and pick up the pile thereon while the latter is being elevated at an average rate corresponding to said given rate to maintain the top of the pile thereon between predetermined levels as the top sheets are removed therefrom, said auxiliary hoist being adapted to be periodically elevated when supporting a pile to maintain the top thereof between said predetermined levels, said auxiliary hoist including vertically movable pile support means, a rotatable shaft operatively connected to said pile support means to raise and lower the support means on rotation of said shaft in opposite directions respectively, a reversible high-speed, rotary air motor, reduction gearing interconnecting said motor and shaft, said reduction gearing having a ratio such that said shaft is rotated when a pile is on said auxiliary hoist to operate said auxiliary hoist at a rate at least as great as said given rate whereby said auxiliary hoist operates at a substantially higher rate than said given rate in the absence of a pile thereon, means for supplying air to said motor comprising solenoid controlled valve means including a first solenoid energizable to operate said valve means to supply air to one side of said motor to effect operation thereof in a direction to raise said hoist, means for energizing said first solenoid

including a first switch actuatable to a first condition to energize said first solenoid, pile height detecting means responsive to the height of the pile, means operatively connecting said pile height detecting means to momentarily actuate said switch to its first condition in response to a low pile detection, holding circuit means responsive to the actuation of said switch to its first condition for maintaining said solenoid energized independently of said switch and including normally closed second switch means, and actuating means for said second switch means responsive to a predetermined rotation of said motor to effect the opening of said second switch means.

4. In a pile changer as defined in claim 3 wherein said shaft is operatively connected to said pile support means by a plurality of flexible suspension members and a plurality of circular members are fixed to said shaft and are connected to said suspension members to wind and unwind said members upon rotation of said shaft.

5. In a pile changer as defined in claim 3 wherein said shaft is disposed over said pile support means and a plurality of chains suspend said pile support means from said shaft, and a plurality of sprockets fixed to said shaft and to said chains and adapted to wind and unwind said chains upon rotation of said shaft in opposite directions.

6. In a pile changer, the structure as defined in claim 3 wherein said reduction gearing includes self-locking meshed gearing elements, one of said elements being fixed to said shaft, and the reduction gearing driven by said motor driving the other of said elements.

7. A pile changer including a main hoist and an auxiliary hoist adapted to be moved upwardly to overtake the main hoist and pick up the pile thereon while the latter is being elevated to maintain the top thereof between predetermined levels and to be periodically elevated when supporting a pile to maintain the top thereof between said predetermined levels, said auxiliary hoist including vertically movable pile support means, a rotatable shaft operatively connected to said pile support means to raise and lower the support means on rotation of said shaft in opposite directions respectively, a rotary air motor, reduction gearing interconnecting said motor and shaft, means for supplying air to said motor comprising solenoid controlled valve means including a first solenoid energizable to operate said valve means to supply air to one side of said motor to effect operation thereof in a direction to raise said hoist, a relay energizable to effect the energization of said first solenoid, a condenser for energizing said relay, a switch having a first position connecting said relay to charge from a power supply, and a second position connecting said condenser across said relay to discharge through said relay and momentarily energize the latter, and holding circuit means made in response to the energization of said relay to complete a holding circuit for energizing said relay independently of said condenser, said holding circuit means including means responsive to rotation of said motor to break said holding circuit and de-energize said solenoid, and pile height detecting means operatively connected to said switch to momentarily actuate the latter from its said first position to its said second position in response to a low pile detection.

8. A pile changer including a main hoist and an auxiliary hoist adapted to be moved upwardly to overtake the main hoist and pick up the pile thereon while the latter is being elevated to maintain the top thereof between predetermined levels and to be periodically elevated when supporting a pile to maintain the top thereof between said predetermined levels, said auxiliary hoist including vertically movable pile support means, a rotatable shaft operatively connected to said pile support means to raise and lower the support means on rotation of said shaft in opposite directions respectively, a rotary air motor, reduction gearing interconnecting said motor and shaft, means for supplying air to said motor, solenoid-controlled valve means for controlling the connection of said motor to exhaust and a source of fluid pressure including a first sole-

noid energizable to supply fluid pressure to one side of said motor and effect rotation in a direction to raise said auxiliary hoist and a second solenoid energizable to actuate said valve means to supply fluid pressure to the other side of said motor and effect rotation thereof in a direction to lower said hoists, means for energizing said first solenoid including a first switch actuatable to a first condition to energize said first solenoid, pile height detecting means responsive to the height of the pile, means operatively connecting said pile height detecting means to momentarily actuate said switch to its first condition in response to a low pile detection, holding circuit means responsive to the actuation of said switch to its first condition for maintaining said solenoid energized independently of said switch and including normally closed second switch means and actuating means for said second switch means responsive to a predetermined rotation of said motor to effect the opening of said second switch means, and circuit means for selectively energizing said first solenoid independently of said switch and for selectively energizing said second solenoid.

9. In a pile changer, pile-supporting means, a rotatable shaft rotatably supported above said pile-supporting means, means operatively connecting said shaft to said pile-supporting means including a plurality of flexible connections having their one ends secured to said pile-supporting means and a plurality of circular members fixed to said shaft, the ends of said connections remote from said pile-supporting means being fixed to said members and said members being adapted to wind and unwind said members upon rotation of said shaft in opposite directions, said members having a diameter such that said hoist is operable between its upper and lower limits by less than 360 degrees of rotation of said shaft, a reversible rotary air motor, reduction gearing operatively connecting said motor to rotate said shaft upon rotation of said motor including self-locking meshed gearing elements, solenoid controlled valve means for controlling the supply of air under pressure to said motor and including first and second solenoid valves respectively energizable to effect rotation of said motor to raise and lower said pile-supporting means respectively, circuit means for selectively energizing said solenoids including first and second switches operable to render said circuit means ineffective to energize said first and second solenoids respectively, means mounting said switches adjacent said shaft, and means actuated in response to the rotation of said shaft to predetermined angular positions corresponding to the upper and lower limit positions of said hoist for actuating said first and second switches when said shaft is at said first and second predetermined angular positions respectively.

10. In a pile changer, pile-supporting means, a rotatable shaft rotatably supported above said pile-supporting means, means operatively connecting said shaft to said pile-supporting means including a plurality of flexible connections having their one ends secured to said pile-supporting means and a plurality of circular members fixed to said shaft, the ends of said connections remote from said pile-supporting means being fixed to said members and said members being adapted to wind and unwind said members upon rotation of said shaft in opposite directions, said members having a diameter such that said hoist is operable between its upper and lower limits by less than 360 degrees of rotation of said shaft, a reversible rotary air motor, reduction gearing operatively connecting said motor to rotate said shaft upon rotation of said motor including self-locking meshed gearing elements, solenoid controlled valve means for controlling the supply of air under pressure to said motor and including first and second solenoid valves respectively energizable to effect rotation of said motor to raise and lower said pile-supporting means respectively, circuit means for selectively energizing said solenoids including first and second switches operable to render said circuit means ineffective to energize said first and second solenoids respectively, means mounting said

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switches adjacent said shaft, and means actuated in response to the rotation of said shaft to predetermined angular positions corresponding to the upper and lower limit positions of said hoist for actuating said first and second switches when said shaft is at said first and second predetermined angular positions respectively, said circuit means further comprising switch means operated momentarily in response to a low pile level detection to momentarily energize said first solenoid and self-holding means responsive to the actuation of said switch means to complete a holding circuit for maintaining said first solenoid energized independently of said switch means, said holding circuit including normally closed contact means actuated to an open condition in response to rotation of said motor to predetermined angular positions to break said holding circuit and de-energize said first solenoid.

11. In an elevating mechanism having a hoist which is to be elevated at at least a given rate when under load and at a substantially greater rate when not under load and which is to be periodically elevated a predetermined increment in response to the momentary actuation of a switch, a first shaft rotatable in opposite directions to raise and lower said hoist, a high speed, reversible rotary air motor having a low inertia rotor, reduction gearing having an input shaft connected to said rotor to be driven thereby and an output shaft and self-locking meshed gears interconnecting said shafts to drive said output shaft from said input shaft, said reduction gearing providing a

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reduction ratio such that said air motor operates at at least said given rate when said hoist is under load and must rotate a plurality of revolutions to effect the raising of said hoist said predetermined increment, electrically controlled valve means responsive to said switch to effect operation of said air motor, and means responsive to the movement of a part driven by said input shaft and rotating at a speed less than said motor to stop said motor.

12. In an elevating mechanism having a hoist which is to be periodically elevated a predetermined increment in response to the momentary actuation of a switch, a first shaft rotatable in opposite directions to raise and lower said hoist, a low torque, high-speed reversible rotary air motor having a low inertia rotor, a self-locking drive connecting said motor to rotate said shaft and including a reduction gearing having a ratio such that said motor must rotate a number of revolutions substantially in excess of a single revolution to displace said hoist by said increment, and control means for effecting operation of said motor by a predetermined angular amount in response to each actuation of said switch.

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