

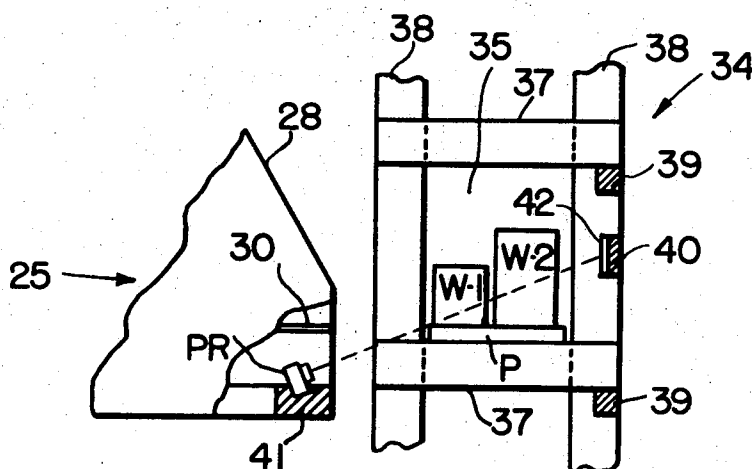
Hartman, III

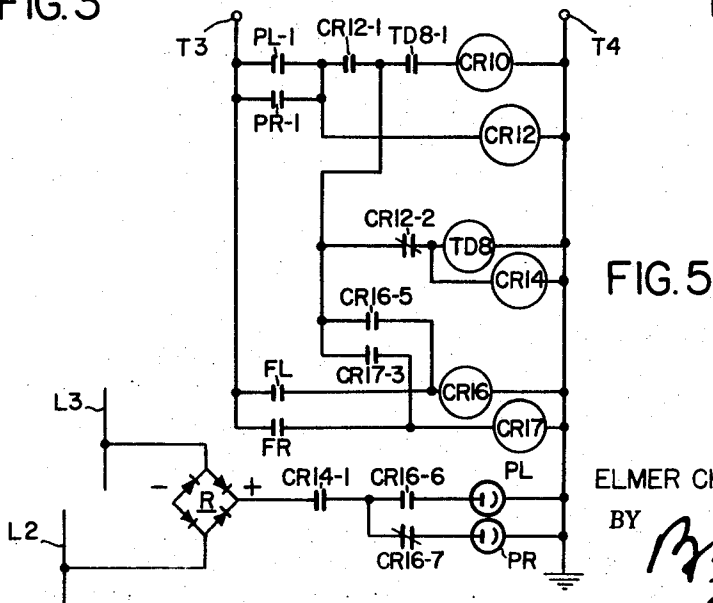
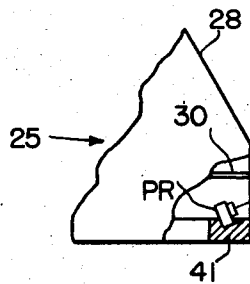
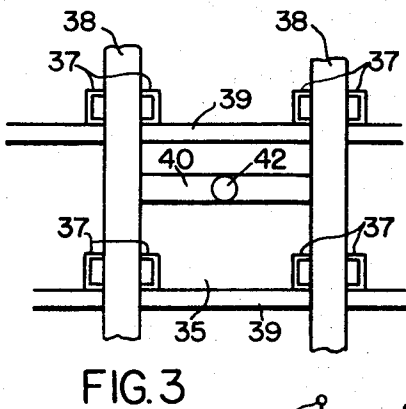
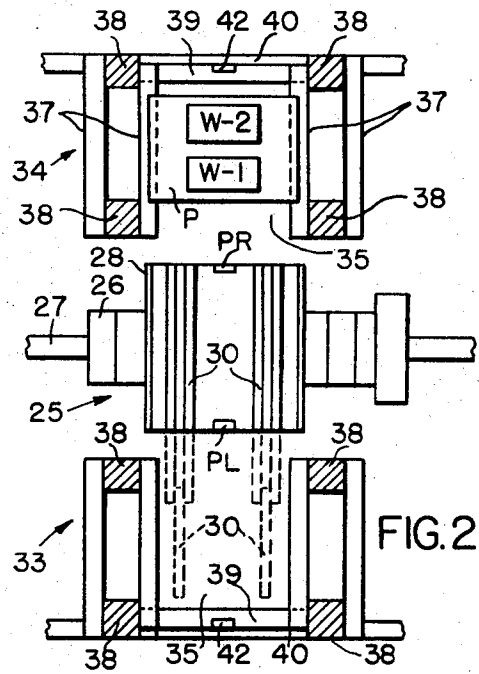
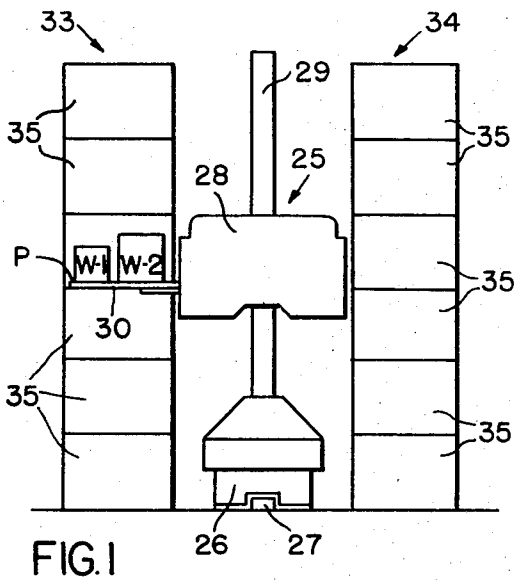
[45] **Aug. 1, 1972**

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| 3,139,915 | 7/1964 | Minard | 250/223 X |
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- In automatic storage apparatus having a load carrier movable under command into registry with a selected bin of the storage rack to transfer a load from the carrier to the bin, a reflector disk is mounted in the back of each bin, and a photoelectric cell is mounted on the carrier to receive reflected light from the disk. When a bin already contains a load the load will block off the reflector so that the cell will not be energized, and the transfer mechanism, which would ordinarily be actuated upon energization of the cell, will not be actuated, so that the mechanism will not attempt to transfer a new load into the already loaded bin.

1 Claim, 5 Drawing Figures





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LOAD DETECTOR FOR AUTOMATIC STORAGE APPARATUS

This invention relates to automatic storage apparatus, and more particularly to novel means for detecting the presence of a load in a storage rack that is serviced by an automatic stacker. The invention relates more specifically to automatic storage apparatus of the type in which an automatic load-carrying stacker is movable down an aisle between a pair of spaced storage racks to deposit a load in, or to withdraw a load from, a preselected bay or bin in one of the two racks.

To prevent a load from being transferred from the stacker into an already loaded bin, it has been the practice heretofore to employ on the stacker a mechanical feeler or arm, which, when the stacker has stopped in registry with the selected bin, is projected into the bin to detect the presence or absence of a load therein.

A major disadvantage of this type of detector is that unless it extends completely through the bin to the back thereof, it may not detect the presence of a load positioned near the back of the bin. Another disadvantage is that the detector usually comprises a plurality of mechanically operated parts, which often are accidentally damaged during operation of the stacker, and which in time wear out and must be replaced.

It is an object of this invention to provide for stacker apparatus of the type described a novel detector device, which will detect the presence of a load in a bin of a storage rack, even when the load is positioned adjacent the rear of the bin.

Another object of this invention is to provide an improved detector device, which will eliminate the need for employing mechanically operated probes or detectors of the type which must be projected physically into a bin in a storage rack to determine the presence or absence of a load therein.

A more specific object of this invention is to provide an improved load-detecting device, which utilizes reflected light rays for detecting the presence or absence of a load in a selected bin of a storage rack.

Other objects of the invention will be apparent hereinafter from the specification and from the recital of the appended claims, particularly when read in conjunction with the accompanying drawing.

In the drawing:

FIG. 1 is an end elevation and FIG. 2 is a fragmentary plan view illustrating schematically an automatic stacker and a pair of storage racks, incorporating a load detecting device made in accordance with one embodiment of this invention;

FIG. 3 is a slightly enlarged, fragmentary front elevational view of one of the storage racks illustrated;

FIG. 4 is a fragmentary side elevational view of the rack, showing part of the stacker in registry with a loaded bin or bay of this rack; and

FIG. 5 is a wiring diagram illustrating one manner in which a load detecting device made in accordance with this invention may be connected to the electrical control circuit of the loading apparatus.

The automatic storage apparatus illustrated herein comprises a programmable load-bearing stacker, which is movable in an aisle between a pair of spaced, parallel storage racks to transfer loads from one bin or bay to another in the storage racks, or to transfer loads between a selected bin or bay and a combination load-unloading station, which is disposed at one end of the

aisle. In each rack the bays or bins have open ends, and are disposed in horizontal rows and vertical columns; and the bins at one side of the aisle register with those at the opposite side of the aisle. The stacker moves horizontally along a rail which extends down the aisle between the racks; and it has a vertically movable elevator portion, which carries a retractable, load-bearing fork mechanism that is capable of extending out of either side of the elevator into a bay in one of the racks.

Mounted on each side of the elevator is a light source, and a photoelectric cell which is operable by reflected light. Mounted on the back of each bin is a disk for reflecting light. When the elevator with a load stops in registry with a bin into which the load is to be deposited, the beam of light from the photocell, that is disposed on the side of the elevator confronting the selected bin or bay, is directed toward the disk that is mounted in the back of the selected bin or bay. If this bin or bay is empty, the beam of light will be reflected back by the disk onto the photoelectric cell, thereby to trip a control circuit which permits the fork mechanism on the elevator to deposit the load in the bin or bay. If, however, there is already a load in the selected bin or bay, it will prevent the light beam from falling upon the reflector at the back of the bay, and no light beam will be reflected back onto the photoelectric cell. As a result, a reject relay in the stacker control circuit is energized, and the fork mechanism on the stacker will not attempt to deposit the load into the already loaded bin or bay.

Referring now to the drawing by numerals of reference, 25 designates generally the automatic stacker. Stacker 25 includes a trolley portion 26, which is movable on a rail 27, between spaced storage racks 33 and 34. The trolley 26 carries a mast 29 on which there is vertically movable an elevator 28 upon which is mounted a transfer mechanism comprising a pair of retractable, load-bearing forks 30. The storage racks 33 and 34, for the purposes of the description herein, will be regarded as the left and the right hand storage racks, respectively. Each rack is divided into a plurality of bays or bins 35. It comprises a plurality of vertical members 38, which are connected at the rear of each rack by a vertically spaced, horizontally disposed beam 39. In each rack the bins 35 are arranged in horizontal rows and vertical columns, with the open ends of the bins confronting one another at opposite sides of the aisle. Secured to the confronting sides of the members 38 at the bottom of each bin 35 are two spaced, parallel, horizontally disposed pallet-supporting beams 37 which extend from front to back of the rack. As thus far described, the racks 33 and 34 are conventional.

Secured between the confronting sides of the vertical members 38 at the back of each bay 35 is a horizontal bar 40. Each bar 40 is positioned between the top and bottom of the associated bay or bin 35, and has secured to the inner or forward face thereof, substantially medially of its ends, a reflective, reflex receiver disk 42.

Mounted on opposite sides of the elevator 28 between its retractable fork members 30 to face the left and right hand racks 33 and 34, respectively, are two identical, conventional photocells PL and PR. Each of these cells is secured to a bar 41 (only one of which is illustrated in FIG. 4), which extends along one side of the elevator at the bottom thereof, and is positioned

below the upper surfaces of the fork members 30 so as not to interfere with the transfer of a load onto, or off of, the elevator. Each cell PL and PR comprises a photoelectric cell surrounded by a light source, which, when energized, directs a beam of light from the elevator toward the adjacent storage rack 33 or 34, as the case may be, at an angle of approximately 15 degrees to the horizontal.

When the loaded elevator is disposed in registry with a pair of confronting bins 35, into one of which the load is to be deposited, the light beam emitted by the cell at the same side of the aisle as this bin, will fall upon the reflective surface of the receiver disk 40 that is disposed in the rear of the selected bin, providing the bin is empty. If, on the other hand, a loaded pallet P is positioned in the selected bin, as illustrated in FIGS. 1 and 4, the light beam (broken lines in FIG. 4) from the cell (PR in FIG. 4) will be blocked off from the associated receiver disk 42 by the loads W-1 and W-2 on the pallet.

Referring now to FIG. 5, lines L2 and L3 represent part of a three phase circuit, which supplies power to a rectifier R, and to a control console that is mounted on the stacker 25 for movement therewith. When the stacker is in operation, an alternating current potential exists between terminals T3 and T4 in the stacker console. Each of switches FL and RF is representative of a plurality of switches in a stacker control circuit. Switch PL-1 is a normally-open switch, which closes when a beam of light from the cell PL is reflected by a receiver disk 42 back onto the cell PL. The normally open switch PR-1 is closed when a beam of light from the cell PR is reflected by a receiver disk 42 on the right hand rack 34 back onto the cell PR. Switch TD8-1 is a time-delayed closing switch, which does not close until several seconds after the energization of its control relay TD8. Relay CR12 controls the motion of the fork mechanism 30, and must be energized before the forks will extend to their broken line positions, as shown in FIG. 2, to deposit a load into one of the racks. Relays CR16 and CR17 determine the direction (right or left) in which the fork mechanism will advance when relay CR12 is energized.

As is well known in the art, the stacker 25 may be programmed for an operation in which it automatically, and successively, picks up a load either from a given bin or bay, or from a loading station, and then deposits the load in a preselected bin or bay in either the left or right hand rack. During movement of the loaded stacker toward the preselected bay, the load is supported on the elevator 28 on the retracted fork mechanism 30. When the elevator has moved into registry with the preselected bay, into which the load is to be deposited (for example the bay 35 in the right hand rack 34, as illustrated in FIG. 4), the stacker 25 is stopped by the control mechanism in such a position that the photocell PR on the right hand side of the elevator registers with the receiver disk 42 mounted at the back of the selected bin.

At this time the control circuit, by means not illustrated, causes the forks-right switch FR to close, thereby energizing the forks-right relay CR17. This closes switch CR17-3 and energizes both the time delay relay TD8 and the relay CR14 through the switches FR, CR17-3 and CR12-2. Relay TD8 starts to

close switch TD8-1; and relay CR14 instantly closes switch CR14-1 so that the light source in the right hand reflex photocell PR is energized from the rectifier R through switches CR14-1 and the normally closed switch CR16-7. As a result, a beam of light is emitted from cell PR toward the receiver disk 42 shown in FIG. 4. Assuming in the first instance that the bay 35 in FIG. 4 is empty (i.e., there are no loads W-1 and W-2 to block the beam of light from the cell PR), the beam will strike the disk 42, and will be reflected back onto the cell PR, thereby causing switch PR-1 to close. This energizes relay CR12 through switch PR-1. Relay CR12 closes the holding switch CR12-1, and opens switch CR12-2 before the time delayed closing switch TD8-1 has had an opportunity to close. This causes the switch TD8-1 to remain open, while the now-energized relay CR12 causes the fork mechanism 30 to be extended to deposit the load thereon into the empty bin 35.

As the fork mechanism extends into the bay, the load thereon will block the beam of light from the relay PR, therefore causing the switch PR-1 once again to open. However, this has no effect upon the circuit, since the relay CR12 remains energized from T3 through the now-closed switches FR, CR17-3, CR12-1 and the relay CR12 to the terminal T4.

Assuming in the second instance that the bay 35 is already loaded, as shown in FIG. 4, when the elevator moves into registry with the bay, the beam of light from the photocell PR will be prevented from falling upon the associated receiver disk 42 by the loads W-1 and W-2. The switch PR-1 therefore will not be closed by reflected light from the disk 42. As a consequence, the relay CR12 will not relay energized, and the time delayed closing switch TD8-1 will finally close energizing the reject relay CR10 through switches FR, CR17-3 and TD8-1. When this occurs, the fork-extending mechanism 30 is stopped before it has had an opportunity to deposit a load into the already loaded bay 35. The stacker 25 then returns automatically to the combination load-unload station.

If the loaded stacker should be programmed to deposit a load into the left hand rack, the switch FL will close, when the elevator portion of the stacker has registered with the selected bay. This energizes the forks-left relay CR16, which closes the switches CR16-5 and CR16-6, and opens the switch CR16-7. The relays TD8 and CR14 are then energized through the switches FL, CR16-5 and CR12-2, thereby closing switch CR14-1 and commencing to close the time delayed closing switch TD8-1. The light source in cell PL is now energized through switches CR14-1 and CR16-6. If the selected bin in rack 33 is empty, the beam from this source will be reflected back by the registering disk 42, thereby closing switch PL-1 to energize the CR12 before the switch TD8-1 has had an opportunity to close. This deenergizes the relays TD8 and CR14, and causes the loaded fork mechanism 30 to advance out of left side, in this instance, of the elevator. If, however, the selected bin in the left hand rack 33 is loaded at the time that the elevator moves into registry with the bin, the switch PL-1 will not be closed, the relay CR12 will not be energized, and the switch TD8-1 will finally close to energize the reject relay CR10 through switches FL, CR16-5, and TD8-1. This returns the loaded stacker to the combination load-unload station.

From the foregoing it will be apparent that the reflux photocell load detectors PR and PL provide very reliable means for detecting the presence of a load in a selected bin in a storage rack, regardless of the depth of the bin. With prior, probe-type detectors, for example, it was necessary to utilize a relatively complicated mechanism for extending the probe into the selected bay, when the elevator was registered therewith. Moreover, with prior detecting mechanisms, a probe may not be extended into a selected bay far enough to detect a load, for example a load W-2, which happens to be positioned adjacent the rear of the selected bay. With the device claimed herein, however, each reflex photocell emits a beam of light which will be interrupted by a load regardless of the distance between the load and the side of the elevator, provided the load is tall enough, or at a height sufficient to interrupt the beam from the associated cell PL or PR.

Furthermore, the photocell detectors PR and PL have no moving parts which must actually come into contact with a load before the detector is tripped, and as a result the operating life of the detector is considerably increased as compared to prior like detectors.

In order to compensate for low loads, each bar 40, or the disk 42 thereon, may be mounted for vertical adjustment. Similarly, although each cell PR and PL is described as being mounted to project a beam of light at approximately 15° to the horizontal, it is obvious that this angle can be adjusted by making corresponding adjustments in the positions of the cells.

While the invention has been described in connection with a specific embodiment thereof, it will be understood, then, that it is capable of further modifications, and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains and as may be applied to the essential features hereinbefore set forth, and as fall within the scope of the invention or the limits of the appended claims.

Having thus described my invention, what I claim is:

1. Apparatus for detecting the presence of a load in a bin of a storage rack of the type which has a plurality of bins arranged in rows and columns horizontally and vertically, and which is serviced by a horizontally movable load carrier that carries a single elevator movable into registry with any selected bin in said rack, said elevator having thereon a transfer member and means operable to insert a load through an open end of said selected bin onto load supporting means therein, said apparatus comprising

cooperating members on the rack and the elevator, respectively, and comprising retro-reflective elements fixed on said rack at the backs of the several bins remote from the open ends of the bins, with their reflective surfaces facing said open ends, a reflex photocell mounted on said elevator below the upper surface of said transfer member, a light source associated with said photocell, means for energizing said light source only when said elevator registers with a selected bin

said light source being operative, when energized, to direct a beam of light diagonally upwardly into said selected bin at an angle to the horizontal, and onto the retro-reflective element disposed in said selected bin, whereby only when said selected bin is empty, is the element operative to reflect light back toward said source along the axis of the beam of light emitted by said source,

light-responsive switch means contained in said reflex photocell to control said transfer member, said light-responsive switch means being disposed to receive reflected light from said surface, when said selected bin is empty, and to be blocked off from said reflected light, when there is a load in said bin, and

control means responsive to said switch means to operate said transfer member, when said reflected light falls on said switch means, and to prevent operation of said transfer member, when a load in said selected bin prevents light from being reflected back onto said switch means.

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